ROCKWELL-COLLINS

KWM-380

Owner's Manual

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owner's manual

Collins KWM-380 Transceiver

Collins Telecommunications
Products Division
Electronic Systems Group
Rockwell International
Cedar Rapids, Iowa 52406

Printed in the United States of America

introduction

This manual contains operating and installation information for the fully synthesized, all solid-state KWM-380 Transceiver. Full coverage from 29.999 99 down to 0.500 00 MHz is standard in the receiver circuits. Transmission is limited to 1.800 to 2.000, 3.500 to 4.000, 7.000 to 7.300, 14.000 to 14.350, 21.000 to 21.450, and 28.000 to 29.700 MHz in the Amateur Radio Service bands. The pll synthesizer tunes in 10-Hz increments either manually or with an optional remote keypad control. Split vfo is standard, as is the digital frequency display driven directly by the microprocessor.

Because of the uniqueness of each individual station, the installation information found here is limited in scope. In-depth information can be found in numerous publications commonly referred to by amateur radio operators.

Test procedures in this manual require only simple test equipment to perform. The procedures are a guide in tracing malfunctions to a functionally related group of circuit cards. Detailed tests requiring laboratory-type test equipment and schematic diagrams are included in the KWM-380 Transceiver Service Manual, Collins publication number 523-0769878.

specifications

Physical	
Size	394 mm (15.5 in) wide, 165 mm (6.5 in) high, (does not include 25 mm (1 in) feet normally attached), 457 mm (18.0 in) deep
Weight	21.8 kg (48 lbs) max
Primary power	Strappable for: 105, 115, 125/ 210, 220, 230, 240, 250 V ±5%, 50 to 60 Hz; or 12 to 15 V dc. 120 W max in receive; 600 W max in transmit
Receiver	
Frequency	0.5 to 30.0 MHz, tunable in 10-Hz steps
Modes	USB, LSB, AM, and CW
Sensitivity	0.5 μV or better for 10 dB (s+n)/n, 2.0 to 30.0 MHz; reduced sensitivity for 0.5 to 2.0 MHz (broadcast band attenuation nominally 30 dB)
Selectivity (3-dB bandwidth)	Selectable 8 kHz *6 kHz 2.1 kHz *1.7 kHz *400 Hz *200 Hz
If and image rejection	Greater than 60 dB

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*Optional filters

Intermodulation distortion .... -50 dB or better for two signals of -10 dB mW each, 20 kHz apart

AGC .... Audio output variation not more than 8 dB for 2-μV to 100-mV open circuit rf input variation

Audio output .... Not less than 3.5 W into 4-ohm load, at 1 kHz, at not more than 10% total harmonic distortion

Line audio output: -10 dB mW nominal into 600 ohms

Frequency response: 300 to 2400 Hz with not more than 5 dB variation

Transmitter

Frequency .... 160- through 10-m amateur bands, tunable in 10-Hz steps

160 m	1.800	-	2.000	MHz
80/75 m	3.500	-	4.000	MHz
40 m	7.000	-	7.300	MHz
20 m	14.000	-	14.350	MHz
15 m	21.000	-	21.450	MHz
10 m	28.000	-	29.700	MHz

Modes .... USB, LSB, and CW

Output power .... 100 W pep, nominal

In CW or RTTY, automatic turn-down to 50 W after 10 seconds, 50 percent duty cycle, key down 15 minutes, max.

With optional blower kit installed, power is 100 W average, 50 percent duty cycle, key down 1 hour, max, at 25 °C; 30 minutes, max, at 50 °C for all modes.

Unwanted signal suppression	
Carrier	-50 dB or better
Undesired sideband, 1-kHz ref	-55 dB or better
Harmonics (all)	-40 dB or better
Mixer products	-55 dB or better
Third order distortion	25 dB below each tone of two-tone test
Synthesizer accuracy and stability	Accuracy within ±5 kHz after 10 minutes warm-up when 39.6- and 455-MHz oscillators are set to within ±3 Hz Stability within ±150 Hz over temperature range of 0 to 50 °C
Rf load	50 ohms, nonreactive. Full power output with vswr of 2:1 or less. Automatic power output turndown with vswr greater than 2:1.
Audio inputs	
Microphone	Low impedance, dynamic; internal strapping for high impedance
Line	600 ohm, unbalanced; 40-mV input sufficient for full rf power output

INSTALLATION

unpacking

The KWM-380 is shipped in two separate cartons. One contains the power transformer, the other contains the transceiver. After carefully unpacking the cartons, check to be sure no shipping damage is evident. Should any damage be apparent, save the cartons and notify the delivery carrier immediately to file claim for damage.

power transformer installation

To eliminate the possibility of the power transformer breaking loose from the chassis and causing further damage during shipment, it is packaged separately. The transformer is quickly installed in five steps with just a 3/8-in open-end wrench, no 12 (3/8-in) nutdriver, and a Phillips screwdriver.

- Using the screwdriver, remove four screws from the bottom of the transceiver (near the rubber feet at each corner) and slide the dust cover off over the heat sink.

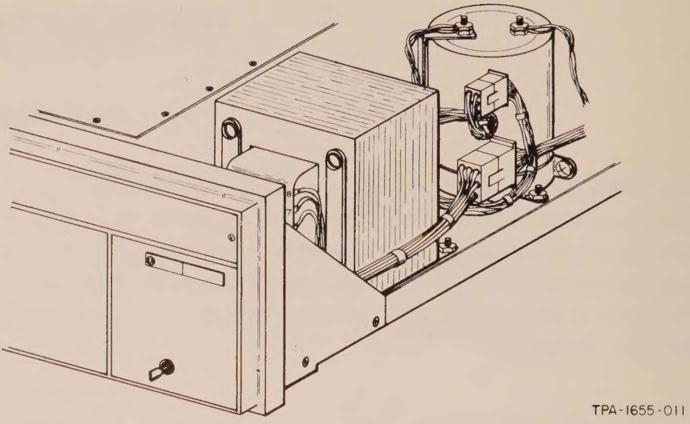
- Remove the front one of the two Phillips-head screws securing the front panel braces to the sides of the chassis and tilt the panel forward.

- Turn the transformer so terminals 1 through 8 face the front panel. With the nutdriver, remove the four nuts and lockwashers from the chassis mounting studs in the right front corner of the chassis and set the transformer over the studs.

- Using the wrench and nutdriver, secure the transformer to the studs with the four lockwashers and nuts.

- Electrically connect the transformer to the transceiver with the two attached polarized connectors. Reattach the front panel, then replace the dust cover.

Figure 1 shows the transformer properly mounted.



Power Transformer Installation
Figure 1

primary power requirements

WARNING

DO NOT ATTEMPT TO CHANGE VOLTAGE STRAPPING WHILE PRIMARY POWER IS APPLIED. ELECTRICAL SHOCK WILL OCCUR. DISCONNECT THE PRIMARY POWER CABLE FROM THE POWER SOURCE OR THE UNIT FIRST.

ac voltage operation

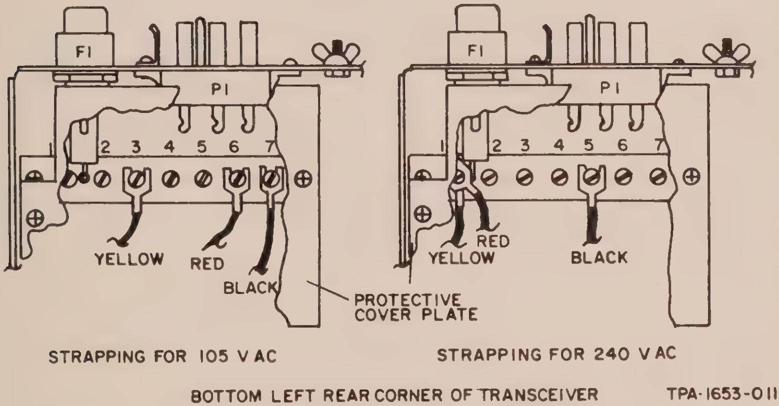
The KWM-380 will operate from various 50- to 60-Hz voltages, depending on the following internal strapping connections.

For input voltages listed, strap TB1 as follows:

WIRE	105	115	125	210	220	230	240	250
BLACK	7	7	7	6	6	5	5	4
YELLOW	3	2	1	3	2	2	1	1
RED	6	5	4	3	2	2	1	1

Determine the average ac voltage at the primary power outlet where the transceiver is to be used. Remove the chassis dust cover and locate the protective cover plate near the left rear corner as viewed with chassis upside down. Remove the cover plate and refer to the preceding chart to make the connections indicated for the voltage nearest the primary power outlet voltage. If the outlet voltage is approximately halfway between two voltages listed, strap TB1 for the lower voltage.

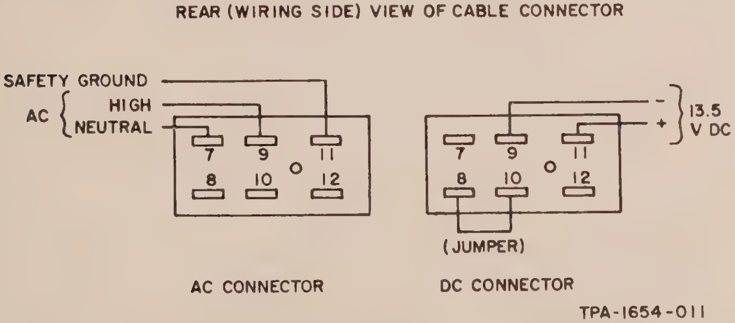
Figure 2 shows TB1 correctly strapped for 105 or 240 volts.



TB1 Strapping for 105 Volts or 240 Volts
Figure 2

dc voltage operation

The KWM-380 will also accept 12 to 15 volts dc for backup emergency power. The primary power connector must be strapped as shown in figure 3. Power requirements are nominally 3 A in receive and 20 A in transmit.



Power Connector Strapping for AC or DC Operation
Figure 3

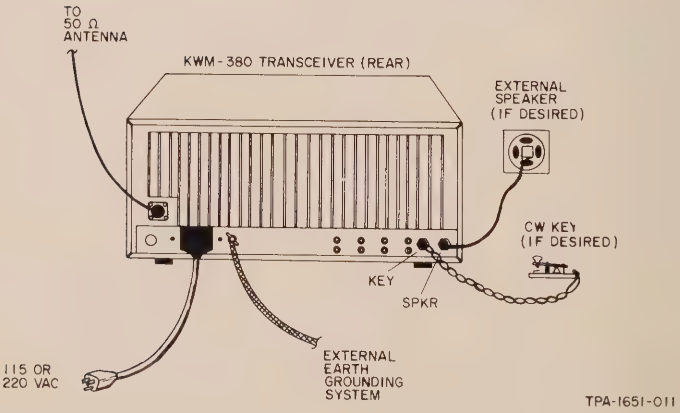
operating location

The normal operating location should be chosen so the transceiver is away from heat vents and normal airflow around it is unobstructed. Do not lay objects on top or against the sides. It is especially important that the heat sink have a free flow of air about it. An automatic turndown circuit will reduce the rf output power if the heat sink overheats. This is for self-protection of the power amplifier final output stages.

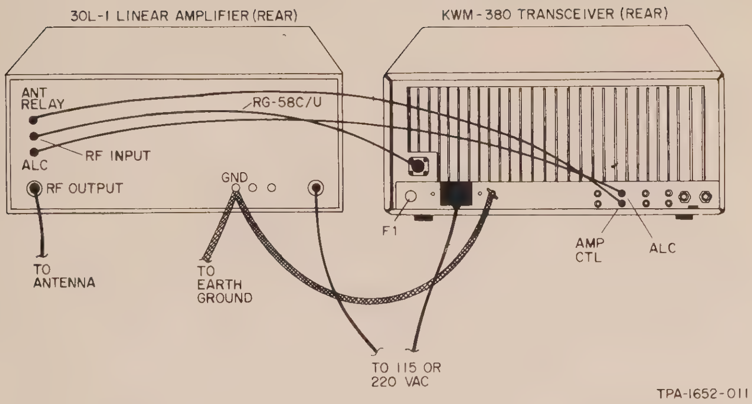
The AC-2808 Blower Kit is available for attaching to the heat sink. This blower supplies cooling air to permit normal operation in close quarters or high-duty cycle operation.

system interconnections

Figures 4 and 5 show typical hookups. Table 1 lists the signal parameters for all front and rear connectors except the primary power and rf input/output.



Transceiver Installation Connections
Figure 4



Transceiver and Linear Power Amplifier Installation Connections
Figure 5

Table 1. Connector Signal Parameters.

CONNECTOR	SIGNAL PARAMETER
Microphone (mates with PJ-068)	Tip—ptt line; ground to transmit Ring—microphone audio; low-impedance input (270 Ω), approx 5 mV in for full power output Barrel—common ground
Headphones (mates with PJ-055)	Tip—receiver audio; 4- to 8-Ω impedance, up to 4-W output Barrel—ground
External SPKR (mates with PJ-055)	Tip—receiver audio; 4- to 8-Ω impedance, up to 4-W output Barrel—ground
CW KEY (mates with PJ-055)	Tip—keying line; ground to transmit Barrel—ground
J2 Line audio in (mates with phono plug)	600 Ω, unbalanced; 40-mV input produces 100-W rf output

Table 1. Connector Signal Parameters (Cont).

CONNECTOR	SIGNAL PARAMETER
J3 ALC (mates with phono plug)	Input for negative ALC voltage from external power amplifier
J4 Antenna relay (mates with phono plug)	External access to receiver contacts of internal antenna transfer relay. Internally jumpered to J8. (Cut jumper if used.)
J5 Transverter (mates with phono plug)	Approximately 200-mW (100-mW, min) output from exciter into 50-ohm load. (To obtain output, connect this line to dc ground through a 1-mH rf choke.)
J6 Line audio out (mates with phono plug)	600 Ω, unbalanced; -10 dB mW at AGC threshold. Level is independent of audio gain control.
J7 Ampl control (mates with phono plug)	Normally open relay contacts; contacts grounded in transmit. 2 A, 28 V dc or 0.75 A, 115 V ac capacity.
J8 Rcvr antenna input (mates with phono plug)	Direct input to receiver front end. Bypasses transmit low-pass filters and antenna transfer relay. Internally jumpered to J4. (Cut jumper if used.)
J9 Push-to-talk (mates with phono plug)	Ground to place transceiver in transmit. (Line is connected to +5 V through 10-kΩ resistor.)

grounding

The importance of a good ground system cannot be overemphasized. All units of the system should have ground interconnections through heavy wire (#12 AWG or larger) or ground strap (6-mm (1/4-in) wide or larger) between ground lugs. Use as short a length of ground wire or braid as practical between units or external ground.

Connect the KWM-380 ground lug on the rear to a good earth or water-pipe ground.

Before using a water-pipe ground, check to make sure that no plastic, rubber, or other such insulating sections will interrupt the electrical continuity to ground. Install a jumper around any insulating sections found. Use heavy copper wire or ground braid and metal pipe clamps.

antennas

The antenna is one of the most important parts in the performance of any radio communications system. System performance is directly related to the efficiency of the antenna. Because each individual installation has unique characteristics, various types of antennas, their characteristics, and installation information cannot be covered in this manual. A number of excellent reference works on antennas are available.

The KWM-380 is designed to operate into a nonreactive rf load of 50 ohms. Impedance mismatches producing vswr's lower than 2:1 are acceptable. For vswr's 2:1 or greater, the transceiver power amplifier output is automatically reduced in proportion to the reflected power.

OPERATION

introduction

Controls on the KWM-380 have been labeled so that their function is self-explanatory. After referring to figures 6 and 7 and tables 2 and 3, many operators will need no further explanation. The following paragraphs summarize operation of several of the controls and give check lists for initial control settings for each operating mode.

frequency selection

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The large tuning knob and row of switches immediately above it control the transceiver frequency selection. When power is applied to the transceiver, the frequency is automatically set to 15.000 00 MHz. Frequency data is not retained in the vfo registers when power is turned off.

There is no need for a bandswitch since selection of the MHz tuning increment permits tuning from 0 to 29 MHz in 1-1/2 turns of the knob. This rate is effective for the MHz digits only. Selecting other increments automatically switches the tuning rate to 200 steps per turn. For example, selecting the 100-Hz increment gives 20 kHz per revolution of the tuning knob.

When a switch is depressed to select a frequency increment to be changed, that and all higher increments will change as the tuning knob rotates. For example, if the 100-Hz increment is selected, the 10-Hz digit remains where last set. Rotating the tuning knob clockwise causes the 100-Hz digits to increment up through 9, index the 1-kHz digit by one, and roll around to 0 to continue incrementing toward 9 again. Counterclockwise rotation causes the frequency to decrement in a similar fashion.

Once a chosen frequency is selected, pressing the LOCK switch to the in position electronically disables the tuning knob operation. In LOCK, rotation of the tuning knob has no effect on the frequency. To restore tuning control to the knob, press the LOCK switch to return it to the out position.

The SYNC switch is momentary and when depressed, will load the displayed frequency value from the operating vfo register into the register that is not being displayed. For example, if using register B, depressing SYNC will load the same frequency into register A. The frequency in register B can then be changed without affecting the stored value in register A.

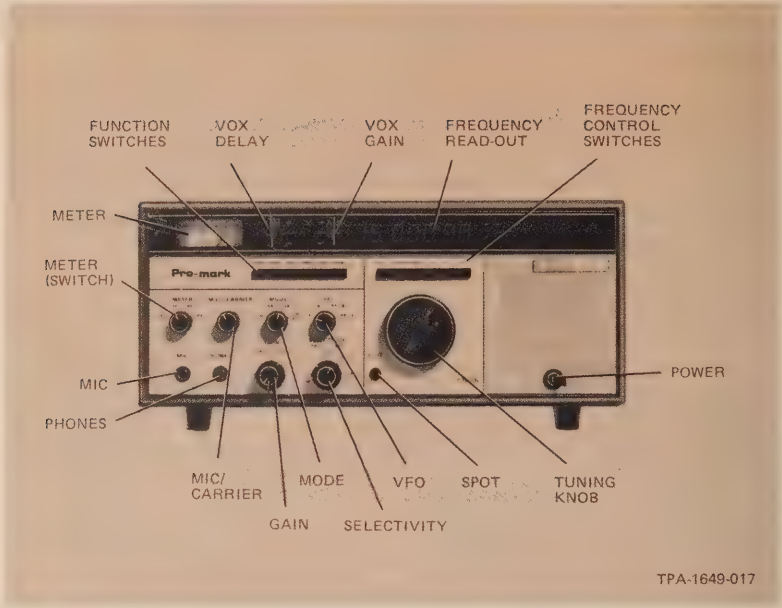
The A and B vfo registers may contain any two frequencies. Split-frequency operation is achieved by selecting RA-TB or RB-TA. With RA-TB chosen, the transceiver will receive on the frequency in the A register and transmit on the frequency in the B register. The frequency display shows the receive frequency when receiving and the transmit frequency when transmitting.

The vfo's can be set up for split-frequency operation on any two frequencies, even within separate bands.

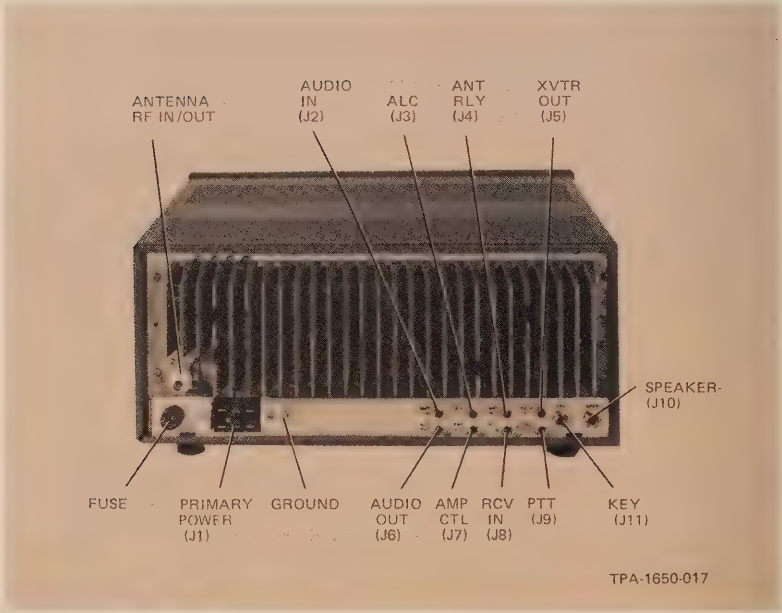
In CW operation, the SPOT switch enables an 800-Hz tone that is applied to the receiver audio output. By tuning the received signal so the CW audio frequency matches the 800-Hz SPOT frequency, the receiver frequency will be matched with the transmitted frequency.

Table 2. Front Panel Controls and Indicators.

ITEM	FUNCTION
METER (switch)	Selects signal applied to meter during transmit.
ALC	Transmitter automatic level control voltage.
VC	Collector voltage for final amplifier stage.
PF	Forward rf power sampled at amplifier output.



Front Panel Controls and Indicators
Figure 6



Rear Panel Connectors
Figure 7

Table 2. Front Panel Controls and Indicators (Cont).

ITEM	FUNCTION
PR	Reflected rf power sampled at amplifier output.
Meter	In receive, indicates relative signal strength in "S" units. (Rf input of 100 μV "hard" (50 μV "soft") gives S9 indication.) In transmit, indicates signal selected by METER switch.
Function switches	Selects related function when switch depressed.
MOX	Manually operated receive-to-transmit switching. Places transceiver in transmit when pressed in.
VOX	Voice operated receive-to-transmit switching. Ptt switching also operable.
NB	Noise blanker.
PROC	Speech processor.
AGC	Receiver automatic gain control.
SLOW	Selects slow AGC action when depressed; fast AGC when out. (AGC switch must be depressed for fast/slow action to be enabled).
DELAY	Adjustments for transmit-to-receive switching time delay.
CW	Delay between last key-up action and receive mode.
SSB	Delay between last microphone VOX input and receive mode.
GAIN	Adjusts levels at which receive-to-transmit switching occurs.
VOX	Voice or line audio input signals.
ANTI	Speaker-to-microphone signals.
Frequency readout	Displays frequency in 10-Hz increments.
Frequency control switches	Selects frequency increments affected by tuning knob. Continuous tuning for any increment with roll-around at end limits.

Table 2. Front Panel Controls and Indicators (Cont).

ITEM	FUNCTION
┐	1-MHz increments.
SYNC	Loads displayed frequency in nonselected vfo register to synchronize both vfo frequencies.
LOCK	Dial lock prevents tuning knob from changing frequency when rotated.
│	1-kHz increments.
┌ (left)	100-Hz increments.
┌ (right)	10-Hz increments.
POWER	Primary power switch.
Tuning knob	Frequency selection control. (Provides 200 increments per revolution for all except MHz steps at 20 increments per revolution.) Works in conjunction with switches above knob.
SPOT	In CW mode only, enables 800-Hz tone to which received CW tone is matched to spot transmitted frequency to exact received frequency.
VFO	Selects frequency-storage register.
A	A register. Transmit and receive on same frequency.
B	B register. Transmit and receive on same frequency.
RA-TB	Receive on A register frequency - transmit on B register frequency.
RB-TA	Receive on B register frequency - transmit on A register frequency.
SELECTIVITY	Controls selectivity of receiver.
PBT (small knob)	Passband tuning. Used to select USB, LSB, or CW during receive mode. Continuously varies position of passband (bandwidth selected by BW control) within 8-kHz passband of first if filter.

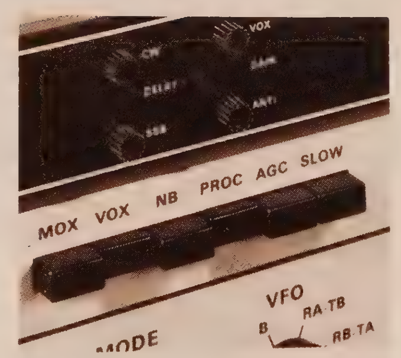
Table 2. Front Panel Controls and Indicators (Cont).

ITEM	FUNCTION
BW (large knob)	Selects filter bandwidth.
8.0	8.0-kHz filter (for AM, also selects optional 6-kHz AM filter if installed).
2.2	2.2-kHz filter (for normal SSB).
OPT 1, 2, 3	Three positions for optional filters.
MODE	Selects mode of transmit operation.
CW	Continuous wave.
USB	Upper sideband. } Receive sideband determined by setting of PBT control.
LSB	Lower sideband.
AM RCV	Amplitude modulation in receive only. Transmitter does not operate in AM mode.
GAIN	Adjusts gain of receiver circuits.
AF (small knob)	Af amplifier gain.
RF (large knob)	Rf amplifier gain.
MIC/CARRIER	In sideband operation adjusts microphone amplifier gain. In CW operation adjusts rf carrier level.
PHONES	Output jack for low-impedance (4- to 8-Ω) headphones. Connecting phones inhibits speaker and SPKR (on rear panel) outputs.
MIC	Input jack for low-impedance, dynamic microphone. Jack is also wired for ptt signal.

Table 3. Rear Panel Connectors.

ITEM	FUNCTION
Antenna	Rf connector (type S0-239) for coaxial cable connection to antenna coupler.
Fuse	Primary power fuse (8 A for 110 V, 4 A for 220 V).
J1	Primary power connector.
Ground	Stud for earth-ground connection.
AUD IN (J2)	Input for 600-ohm, unbalanced line audio.
ALC (J3)	Negative ALC input signal from external power amplifier.
ANT RLY (J4)	Receive contacts of internal antenna transfer relay. (Jumpered to RCV IN (J8) if separate receive antenna not used.)
XVTR OUT (J5)	Exciter output signal for use with transmitting converter.
AUD OUT (J6)	Output for 600-ohm, unbalanced line audio.
AMP CTL (J7)	Relay contacts for tr-switching external power amplifier. (Contacts grounded in transmit mode.)
RCV IN (J8)	Receiver front end signal input. Bypasses antenna transfer relay and transmit low-pass filters. (Jumpered to ANT RLY (J4) if separate receive antenna not used.)
PTT (J9)	Push-to-talk switch input. Ground to command transmit operation.
KEY (J10)	CW key input.
SPKR (J11)	Output for 4- to 8-ohm speaker. Disconnects internal speaker when external speaker connected. (Inhibited when headphones connected to PHONES jack on front panel.)

function switches



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Depressing the MOX or VOX switch selects manual- or voice-operated keying, respectively. The rear panel PTT jack (J9), when grounded, will key the transmitter regardless of MOX or VOX selection.

When pressed to the in position, the MOX switch keeps the transceiver continuously keyed. For normal transmit-receive operation, the MOX switch must be out. With MOX and VOX both out, the transceiver is keyed with the microphone ptt switch. Selecting VOX enables voice keying in sideband or CW keying in CW.

The AGC function can be enabled by depressing the AGC switch. The out position inhibits AGC operation. Release time of the AGC is controlled by the SLOW switch. The in position selects a slow release time. This is normally used in SSB operation. Fast AGC release, the switch out position, is more useful for CW reception.

The optional noise blanker and speech processor circuits, when installed, are selected by depressing the respective NB or PROC switch to the in position. The noise blanker reduces or eliminates pulse-type noise, such as from automobile ignition systems, from the receiver audio output. The speech processor increases the ratio of average to peak power in the rf output signal. This increases talk power and may be desired in DX operation.

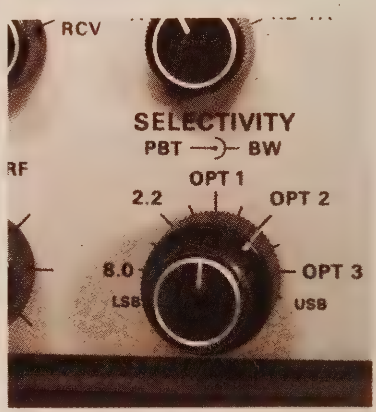
The DELAY controls adjust the time the transceiver is held in the transmit mode after the voice input or CW keying signal is removed. Clockwise adjustment of either control increases the delay between the last input and automatic transmit-to-receive switching. Independently set these controls as desired for the preferred delay times.

The GAIN controls adjust the sensitivity to microphone input signals from the operator (VOX) or from the receiver speaker (ANTI-VOX). Set the VOX GAIN so the normal voice level used during transmitting keeps the transceiver keyed. A level too high may cause background noises to key the transmitter while a level too low will require a loud voice input to the microphone for keying. Set the ANTI-VOX GAIN to a level that prevents the microphone pickup of the speaker output from tripping the VOX circuit.

selectivity

The large (rear) BW switch controls the receive bandwidth by selecting any one of the installed filters.

The small (front) PBT control positions the passband of the selected filter within the 10-kHz passband of the receiver first if and is used to select the desired sideband in receive. For LSB, position the pointer to near 2.2. For USB, position the pointer to near OPT 2.



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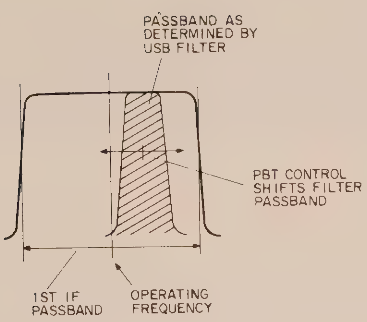
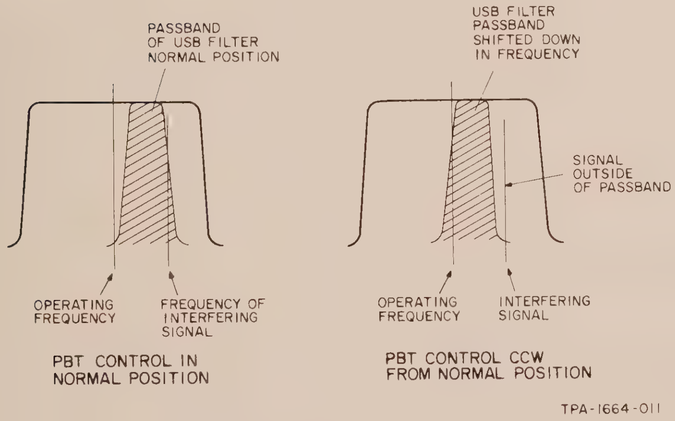
NOTE **The MODE switch does not determine which sideband is received. It only selects the desired transmit passband.**

The PBT control can shift the position of the receive selectivity by adjusting the passband above or below the normal frequency position. By adjusting the PBT control toward the left of center, the filter passband is shifted to a lower frequency. Positions right of center shift the passband to a higher frequency. Figure 8 illustrates this. Figure 9 illustrates how the passband can be tuned away from an interfering signal to put the signal outside the passband and eliminate the interference.


PASSBAND AS DETERMINED BY USB FILTER
PBT CONTROL SHIFTS FILTER PASSBAND
1ST IF PASSBAND
OPERATING FREQUENCY
TPA-1665-011

Filter Passband Positioning With PBT Control
Figure 8


PASSBAND OF USB FILTER NORMAL POSITION
USB FILTER PASSBAND SHIFTED DOWN IN FREQUENCY
SIGNAL OUTSIDE OF PASSBAND
OPERATING FREQUENCY
FREQUENCY OF INTERFERING SIGNAL
OPERATING FREQUENCY
INTERFERING SIGNAL
PBT CONTROL IN NORMAL POSITION
PBT CONTROL CCW FROM NORMAL POSITION
TPA-1664-011

Passband Tuning To Eliminate Interfering Signal
Figure 9

mic/carrier

The MIC/CARRIER control adjusts the audio modulation level or the CW carrier level to control the rf output power. For voice operation, set the METER switch to ALC. Key the transmitter and speak into the microphone or say "Ahhhh" in a normal operating-voice level while adjusting the MIC/CARRIER control until the meter indicates +10 to +20 dB over S9 on the S-unit scale. A more counterclockwise position of the control will give less than this full power output setting.

For CW operation, set the METER switch to PF. Key the transmitter and adjust the MIC/CARRIER control clockwise until no further increase in power is noted. A more counterclockwise position of the control will give less than this full power setting.

operating check lists

Adjustments of the KWM-380 controls will vary with individual operators. The following check lists give initial control settings for each mode of operation. After setting up the transceiver, the controls may be adjusted as desired during operation.

These check lists assume that the equipment is properly installed, the microphone or CW key connected, and the DELAY and GAIN controls adjusted.

CW operation

- Turn on POWER.
- Set MODE to CW.
- Select VFO A or B.
- Adjust RF and AF GAIN to desired levels.
- Select desired BW.
- Set PBT to midrange (vertical position).
- Select unused frequency near desired operating frequency.
- Set METER to PF.
- Select VOX function.

- Key transceiver and adjust MIC/CARRIER to power output level desired (normally until power does not increase with continued increase in MIC/CARRIER level).
- Release key and tune to operating frequency.

SSB operation

- Turn on POWER.
- Set MODE to LSB or USB, as desired for band of operation.
- Select VFO A or B.
- Adjust RF and AF GAIN to desired levels.
- Select 2.2-kHz bw.
- Set PBT to second index mark to left (LSB) or right (USB) of top center.
- Select unused frequency near desired operating frequency.
- Set METER to ALC.
- Press in VOX function switch if ptt operation not desired.
- Key transmitter and speak into microphone while adjusting MIC/CARRIER to power output level desired (normally to level where meter indicates +10 to +20 dB over S9 on S-unit scale).
- Unkey and tune to operating frequency.

RTTY operation

- Make sure microphone is disconnected.
- Turn on POWER.
- Set MODE to LSB.
- Select VFO A or B.

- Adjust RF and AF GAIN to desired levels.
- Select 2.2-kHz bw.
- Set PBT to second index mark to left of top center.
- Set METER to PF.
- Select unused frequency near desired operating frequency.
- Press in MOX function switch (transceiver keys).
- Adjust MIC/CARRIER to power output level desired (normally until power does not increase with continued increase in MIC/CARRIER level).
- Press MOX function to release to out (unkeyed) position.
- Tune to operating frequency.

CQ Reviews:

The Rockwell-Collins KWM-380 Transceiver

BY JOHN J. SCHULTZ*, W4FA

The clean front-panel layout of the KWM-380 rather belies the extremely sophisticated operating features contained in the unit. It covers all the amateur bands on transceive and 1.8 to 30.0 MHz on general-coverage receive, but where is the bandswitch?

The Rockwell/Collins advertisements for the KWM-380 contain a nostalgic scene with some S-Line gear. It makes for a nice advertisement display, but no one should imagine that the KWM-380 has anything in common with the old S-Line gear except a bit of nostalgia. The KWM-380 is a completely new transceiver concept from the ground up.

The KWM-380 h.f. transceiver makes quite an impression when one first receives it as I did in a rather huge package. Unpacking it, one finds a unit that measures about 16″×18″×7″ and weighs in at almost 50 lbs. For its power class as a nominal 100 watt output transceiver, it is several times larger and/or heavier than quite a few transceivers on the market, although one should note that it is a complete station package. That is, it contains a speaker, power supply, the equivalent of a second v.f.o., and space for a host of accessory items, such as a unique type of new speech processor. The space and weight involved is not wasted. The transceiver is filled with circuitry and interesting features, as it should be for its price class.

Taking a look at the transceiver's condensed specifications as shown in Table I, one can see some interesting features. The transceiver basically covers the 1.8 to 30 MHz range[1] in 10 Hz steps with a four-speed tuning capability on receive and nominally only the 160–10 meter amateur bands on transmit. WARC bands are provided for by a simple modification. The receive coverage is not specified in terms of "bands," because from an operating viewpoint they do not exist. The tuning coverage is truly continuous, in that, as described later in more detail, one simply rotates the tuning knob to go from 1.8 to 30 MHz. There is no bandswitch nor any receive or transmit tuning controls other than the main tuning knob.

The rest of the specifications call for very "tight" frequency readout accuracy and stability, a nominal 100 watt output, very good unwanted signal suppression values on transmit, and an exceptional combination of good receive sensitivity with a +15 dBm third-order intercept point. Just reading through the specifications, one senses that the KWM-380 should be an exceptional transceiver. The physical impact of the KWM-380 only serves to enforce this expectation—not because of its weight, but because of its exceptionally "clean" panel layout and extremely clear and large digital frequency display.

As it turns out, the KWM-380 is an exceptional piece of equipment. Someone such as myself who enjoys understanding and writing about circuitry detail could probably generate several volumes on the KWM-380. However, I'll try to resist over-indulgence in that aspect of things in favor of giving you a general description of the electrical concept of the KWM-380, while highlighting a few specific circuits, some comments on the KWM-380's physical make-up, results of test measurements, operating impressions, and finally, details on a few of the most interesting accessories available for the KWM-380.

Circuitry

Fig. 1 shows an overall block diagram of the KWM-380. The receive and transmit signal chains do utilize some common circuits, but if one notes the arrows on the diagram for their signal flow, one can separate them fairly well. For instance, the receive signal path starting at the antenna (upper left corner) goes through a low-pass filter and a.g.c. blocks to a first mixer stage. This mixer stage receives local frequency injection in the range of 39.145.00 to 69.144.99 MHz from a synthesizer block and produces the first i.f. output at 39.145 MHz. The 39.145 MHz i.f. signal goes through a broad 4-pole crystal filter and on to the second mixer, which produces the second i.f. frequency of 455 kHz. The i.f. frequency is translated to 6.255 MHz in a passband tuning circuit and then retranslated back to 455 kHz. The final 455 kHz signal is routed through a product detector for s.s.b./c.w. or to an a.m. detector and then on to a c.w. audio filter and the a.f. amplifier stages.

The transmit signal path starts with a balanced modulator at 455 kHz (upper right of fig. 1), goes through the sideband filter associated with the 6.255 MHz passband tuning circuit, is retranslated to 455 kHz, then is up-converted to the 39.145 MHz i.f., and finally is translated in the same mixer which handles the incoming receive frequency to the output frequency.

All of the frequency conversions used in the KWM-380 may seem a bit confusing, but they are designed to accomplish

---

*c/o CQ Magazine

[1] *The synthesizer range actually covers 0–30 MHz. The Collins specified operating range is 1.8–30 MHz.*

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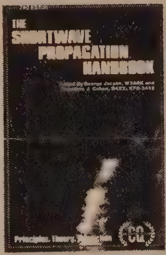

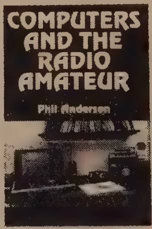

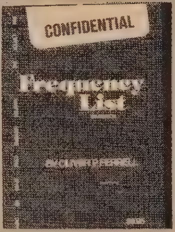

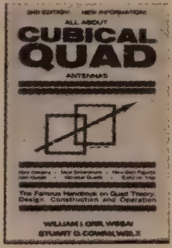

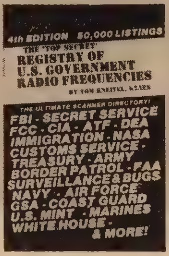

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Parameter	**Specifications**
Physical	
Size	394 mm (15.5 in.) wide; 190 mm (7.5 in.) high, including 25 mm (1 in.) feet; 457 mm (18.0 in.) deep
Weight	27.2 kg (50 lb.), max
Environmental	
Operating temperature	0 to 50°C (32 to 122°F)
Operating humidity	0 to 90% relative humidity
Operating altitude	0 to 3049 m (0 to 10,000 ft.)
Vibration	2 g's, 10 to 33 Hz
Electrical	
Primary power	Strappable for: 105, 115, 125/210, 220, 230, 240, 250 V ±5%, 50 to 60 Hz; or 12 to 15 V dc, negative ground: 120 watts max in receive, 600 watts max in transmit
Receiver	
Frequency	0.5 to 30.0 MHz, tunable in 10 Hz steps
Modes	u.s.b., l.s.b., a.m., and c.w.
Sensitivity (Using "soft µV measurement)	0.5 µV or better for 10 dB (s + n)/n, 2.0 to 30.0 MHz, s.s.b. and c.w.; 1.0 µV or better for 1.8 to 2.0 MHz.
Selectivity (3 dB bandwidth)	Selectable: 8 kHz *1.7 kHz *6 kHz *360 Hz 2.1 kHz *140 Hz *Optional Filters*
I.f. and image rejection	Greater than 60 dB
Intermodulation distortion	−50 dB or better for two signals of −10 dB mW each, 20 kHz apart
AGC	Audio output variation not more than 8 dB for 4 µV to 200 mV open circuit r.f. input variation
Audio output	Not less than 3 W into 4 ohm load, at 1 kHz, at not more than 10% total harmonic distortion Line audio output not less than −10 dB mW nominal into 600 ohms Frequency response: 300 to 2400 Hz with not more than 5 dB variation
Transmitter	
Frequency	160 through 10 m amateur bands, tunable in 10 Hz steps 160 m 1.800 to 2.000 MHz 80/75 m 3.500 to 4.000 MHz 40 m 7.000 to 7.300 MHz 20 m 14.000 to 14.350 MHz 15 m 21.000 to 21.450 MHz 10 m 28.000 to 29.700 MHz
Modes	u.s.b., l.s.b., and c.w. (RTTY by AFSK on l.s.b.)
Output power	90 W pep, min (100 W, nominal) In c.w. or RTTY: 50% duty cycle; key down 15 minutes, max. Automatic turndown to 50 W after 10 seconds. With optional blower kit installed, power is 100 W average, 50% duty cycle, key down 1 hour max at 25°C; 30 minutes max at 50° C for all modes.
Unwanted signal suppression	
Carrier	−50 dB or better
Undesired sideband, 1 kHz ref	−55 dB or better
Harmonics (all)	−40 dB or better
Mixer products	−50 dB or better
Third order distortion	25 dB below each tone of 2-tone test
Synthesizer accuracy and stability	Accuracy within ±5 Hz after 10 minutes warmup when 39.6 MHz and 455 kHz oscillators are set to within ±3 Hz. Stability within ±150 Hz over temperature range of 0 to 50°C (32 to 122°F) if oscillator's set within 10 Hz at 25°C (77°F)
Antenna impedance	50 ohms, nonreactive. (Full transmitter power output with v.s.w.r. of 2:1 or less. Automatic power output turndown with v.s.w.r. greater than 2:1.)
Audio inputs	
Microphone	Low or high impedance, dynamic; 3.3 kΩ nominal impedance
Line	600 ohm, unbalanced; 40 mV input sufficient for full r.f. power output

Table I– Manufacturer's specifications.

various specific functions. An examination of slightly more detailed receive and transmit signal path block diagrams should help to clarify the situation.

For instance, fig. 2 shows details of the receive signal path. The "front-end" of the KWM-380 is unique in several respects. There is no r.f. amplifier stage, and there are none of the usual bandpass filters as are usually associated even with transceivers having a "high" first i.f. (above 30 MHz). The filter blocks that an incoming signal goes through before being amplified are not quite what one would expect. The first filter block is a 0.5–1.6 MHz rolloff one, simply designed to protect the transceiver from BC band overload. The high-pass filter block works in conjunction with a following 30 MHz low-pass filter block. The latter is fixed in frequency at 30 MHz, while there is a selection of three high-pass filter cutoffs of about 20, 14, or 7 MHz. So, an incoming signal can be "bracketed" between 7–30 MHz, 14–30 MHz, or 20–30 MHz.

The reason for this arrangement is not simply to provide image signal rejection; the very high first i.f. frequency takes care of that. The high-pass filters ensure that the transceiver does not generate second order intermodulation products of commercial/broadcasting stations. For instance, in the European area the "breakthrough" of 13–15 MHz signals on "simple" transceivers operating on 10 meters can be a very severe problem. The problem doesn't exist with the KWM-380. In between the high- and low-pass filter blocks one can see a PIN diode attenuator (CR104). This diode is controlled by a voltage from a.g.c. amplifiers in the KWM-380. Essentially, the diode performs the same function in an automatic fashion as the manual r.f. attenuator switches one finds on many h.f. transceivers.

The 39.145 MHz i.f. signal is produced by the first "U100" mixer. This i.f. signal is amplified, passes through an optional noise blanker unit, and then goes on to mixer "U102," where the i.f. signal is translated to 455 kHz and routed to a passband tuning assembly. An up/down frequency translation takes place in this assembly in that the 455 kHz i.f. is translated to an i.f. of 6.255 MHz and then back down again to 455 kHz. True signal selectivity takes place in crystal filters associated with the 6.255 MHz i.f. The final 455 kHz i.f. signal is demodulated to provide an audio output and rectified to provide the control voltage for an elaborate "hang" a.g.c. loop which controls both the incoming signal attenuation (PIN diodes between the high-pass and low-pass filter blocks) and the final 455 kHz i.f. signal attenuation (PIN diodes before the "U700" stage shown in fig. 2). The **800 Hz Spot Tone** input shown in the lower left-hand corner of fig. 2 provides for a convenience feature, in that in the c.w. mode only, one can enable an 800 Hz test tone

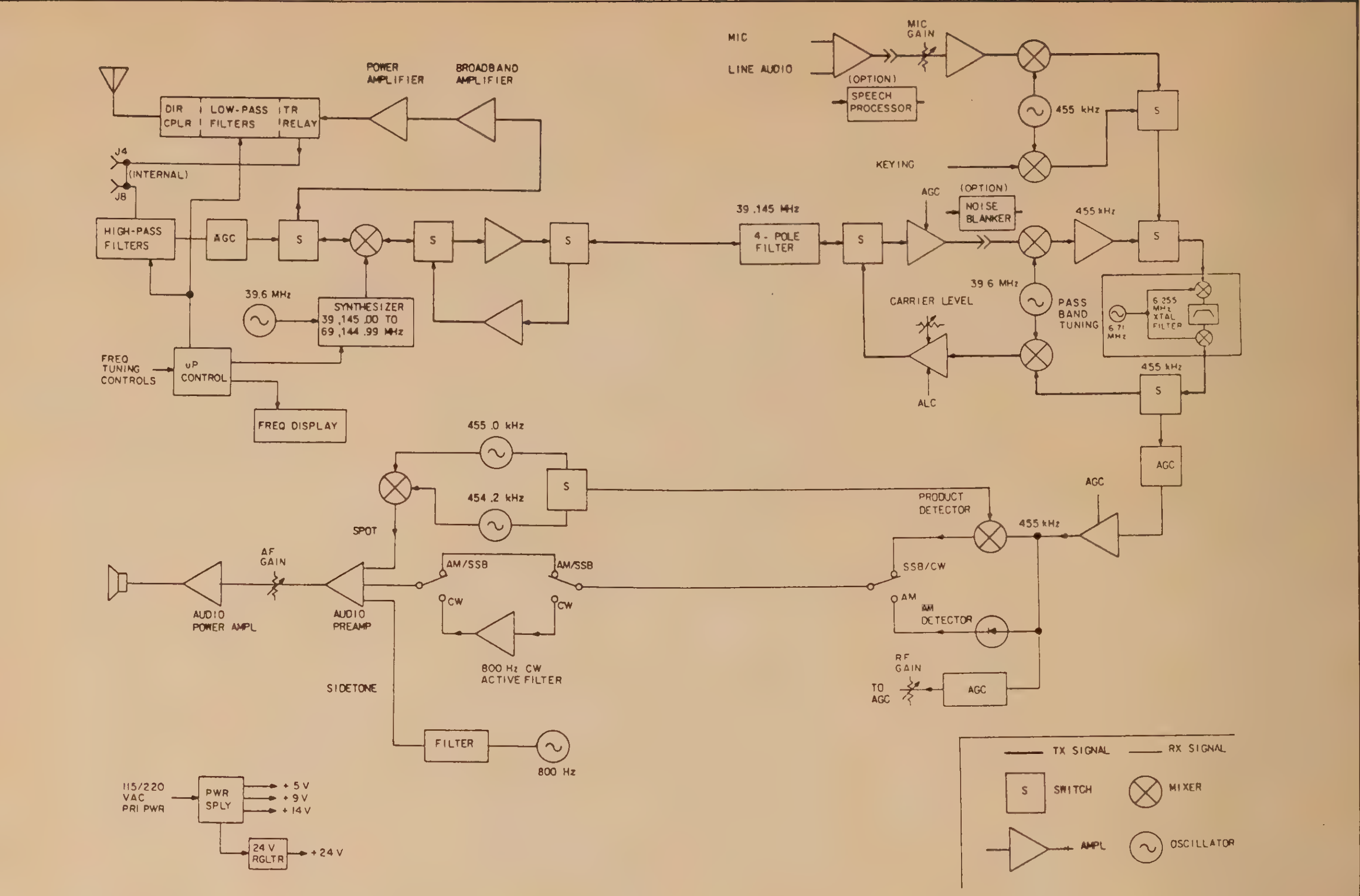


Fig. 1– Overall block diagram of the KWM-380.

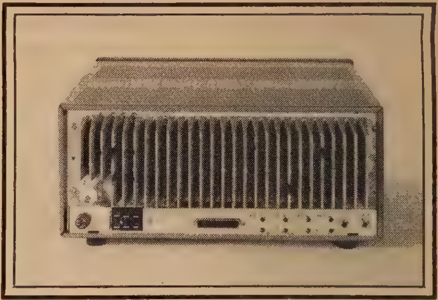
to which a received c.w. tone (centered on 800 Hz by a c.w. i.f. filter) can be matched for exact transmit/receive frequency coincidence.

It would be fun to highlight in detail numerous unique circuits used in the KWM-380. However, if one has to use a practical approach by both serving potential purchasers of the KWM-380 and giving readers some circuit ideas, the following should be of special interest.

The basic "front-end" of the KWM-380 is shown in fig. 3. This diagram shows in detail and with circuit values the various filter sections previously mentioned. The antenna signal first encounters the multiple-pole BC band rolloff filter shown as L800-804 and C800-801. The three high-pass filters are each composed of a similar number of components (e.g., five capacitors and two inductors). The 100 μh coils on each side of each filter are RFC's which are used for signal isolation in the PIN diode switching scheme used.

If one studies the diagram a bit, it should be clear that when point K(7) is grounded, the filters are bypassed by diodes CR800-801. When one of the points L(7), M(7), or N(7) is grounded, one of the three filters is selected. The incoming signal then passes on to the diode section between C825-C102. This diode section is an overload protector composed of zener diodes VR100-101 and limit at the 7 volt level. C104 is switched to ground by the variable resistance of PIN diode CR104, which in turn is driven by the chain of a.g.c. amplifiers shown at the bottom of this diagram. The incoming signal then goes through the fixed 30 MHz low-pass filter and on to mixer U100. U100 is a commercial diode ring mixer (type SRA1H from Mini-Circuits Lab., Brooklyn, N.Y. 11229). The signal is, of course, then translated to the first i.f., but note that only then does signal amplification take place. The whole "front-end," so far, has been passive.

The concept and practical usage of the passband tuning used in the KWM-380 is illustrated in fig. 4. The 455 kHz signal coming into mixer U4 has a bandwidth up to 8 kHz. After mixing, the resultant 6.255 MHz signal is routed to any one of five crystal filters: a standard s.s.b. filter (2.1 kHz), standard a.m. filter (8.0 kHz), an optional narrow filter for s.s.b. (1.7 kHz), or optional narow filters for c.w. (140 or 360 kHz). One also has the option of physically substituting an optional 6.0 kHz filter for a.m. for the standard 8.0 kHz one. These filters are all switched in and out by some diode/transistor switching circuitry as controlled by the front-panel selectivity control. The 6.255 MHz signal is then retranslated to 455 kHz in mixer Q1. Since mixers U4 and Q1 have a common injection oscillator, varying the frequency of that oscillator moves the selected filter bandwidth chosen within the overall incoming 8 kHz bandwidth of the incoming 455 kHz signal. The effect of all this is shown in fig. 4(B). It shows the passband tuning effect as one varies the passband tuning control when a standard s.s.b. filter has been selected. Two things should be noted: the filter bandwidth does not vary as its placement is varied, and the operator must set the passband tuning control so either l.s.b. or u.s.b. signals are passed.



The back panel of the KWM-380 consists almost entirely of a huge heat sink. No blower fan is necessary for normal s.s.b./c.w. operation. Various jacks for accessory connections are shown on the bottom of the panel. The r.f. output connector (left, bottom) is really an SO-239. A u.h.f./BNC adapter was left in place by mistake while taking the picture.

Referring back to fig. 1, one can note that the microprocessor control block

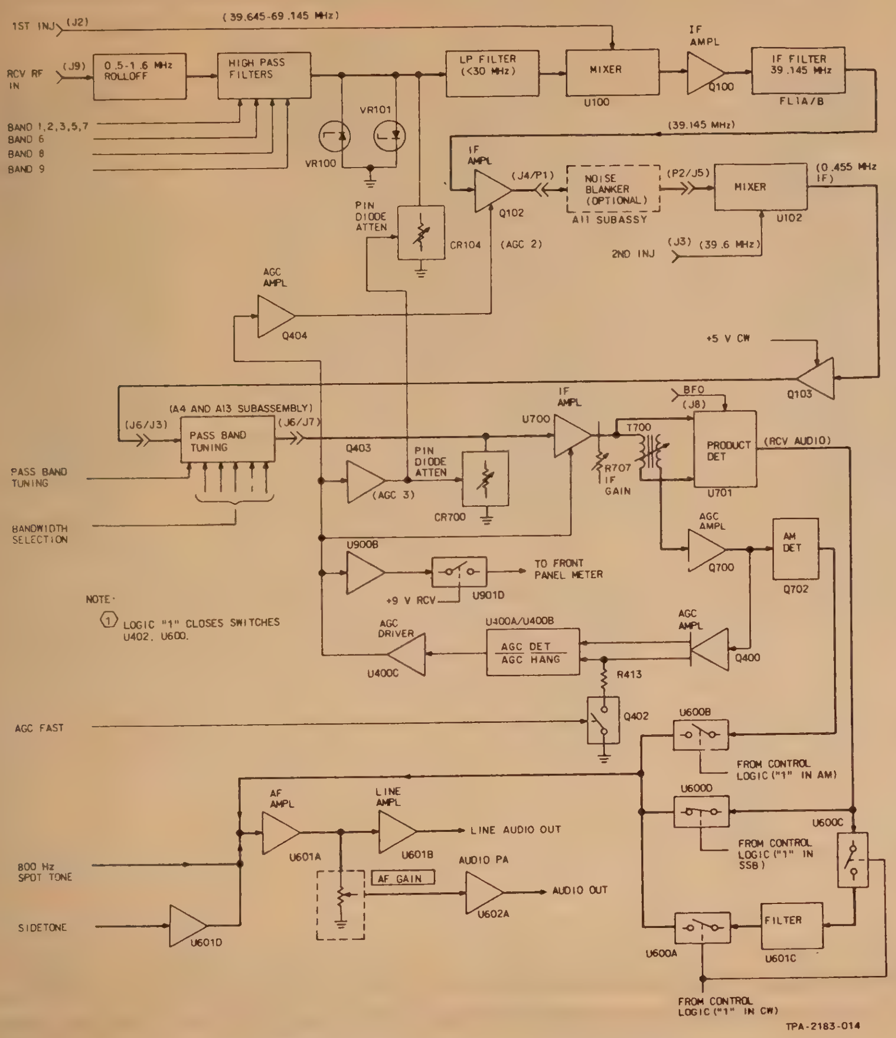


Fig. 2– Block details of the receive chain in the KWM-380.

commands a central position as regards accepting input commands from the frequency tuning controls and then sending out data to various blocks such as those for the synthesizer, frequency display, and high-pass and low-pass filters. The CPU itself is a type 6802. There would be no point in going into all the complex circuitry within the microprocessor and its associated blocks. For example, there are several complex PLL loops within the synthesizer. But, the general concept of control exercised by the microprocessor is interesting. It accepts tuning information from the main tuning knob via photochoppers and senses if the tuning knob rotation is *up* or *down.* It also accepts tuning rate control information from switch settings. It then supplies this data to the synthesizer for frequency generation in 10 Hz steps and to the frequency display for readout to 10 Hz steps. When certain frequency limits are reached, it sends controls to diode switch *in* or *out* high-pass filters in the receive signal chain and relay switch low-pass filters in the transmit signal chain.

Frequency set information is stored for the two A/B v.f.o.'s in the KWM-380 during operation, and the two frequencies can be anywhere within the operating range of the transceiver. However, when power is turned off and then turned on again, the v.f.o.'s are always reset to 15 MHz. The frequency generation and control is arranged such that frequency coverage is continuous without any break for "bands." That is, if the fastest tuning rate is chosen, three revolutions of the tuning knob will completely set the transceiver on any desired frequency between 3.000.00 and 29.999.99 MHz (receive mode; transmit mode is limited to amateur band segments). The other selectable tuning rates are 200 kHz, 20 kHz, and 2 kHz for one main tuning knob revolution.

Fig. 5 shows a few details of the transmit chain in the KWM-380. The basic modes generated are s.s.b. and c.w. For s.s.b. generation a d.s.b. signal is generated at 455 kHz in balanced modulator U501. The signal is then routed through the 2.1 kHz filter contained in the passband tuning circuit used on receive and translated again to 455 kHz as an s.s.b. signal. On transmit, a front-panel mode switch automatically sets the variable oscillator in the passband tuning circuit so a selected l.s.b. or u.s.b. signal is generated. In this manner, and considering the action of the passband tuning control on

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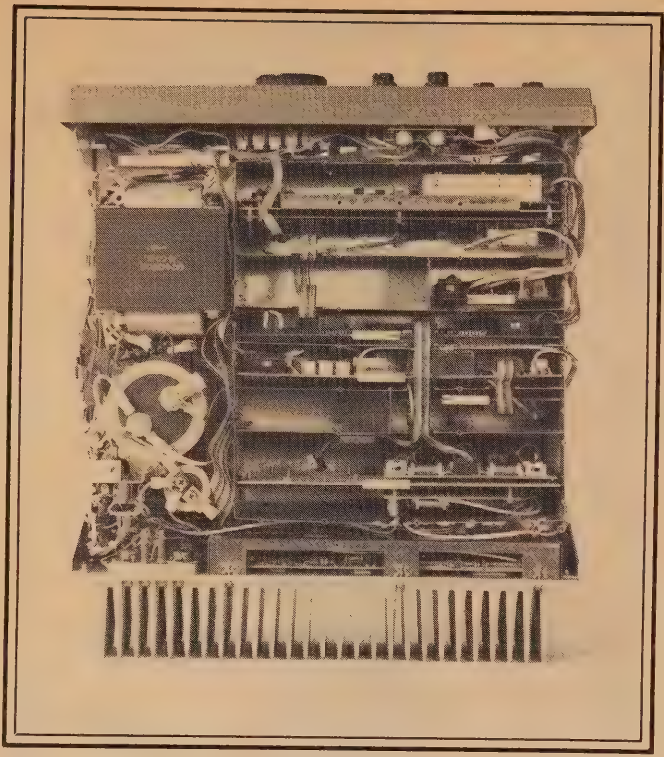
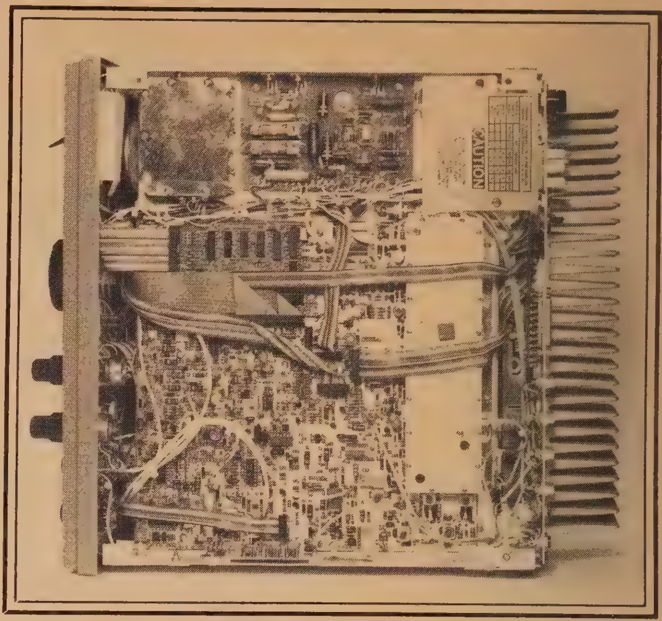


Removing the overall shell cover on the KWM-380 plus an internal shield cover, this is what one will see. The individually shielded compartments on the right contain various PC boards, while the internal power supply components (transformer, filter capacitor, etc.) are seen to the left.



Looking inside the bottom of the KWM-380 with its cover removed, one sees basically one huge, double-sided PC board which contains the basic receive/transmit circuitry (excluding filters, oscillators, frequency readout circuitry, etc.). Note the extensive use of ribbon-type cable with connectors.

receive, one has independent control of sideband selection for transmit/receive. The 455 kHz s.s.b. signal is further frequency translated up to the final operating frequency by the same mixer/oscillator circuits active in the receive mode. The signal reaches the 100 mW level in broadband amplifier stage Q202-204 and is fed on to a power amplifier block.

For c.w. operation, the 455 kHz carrier signal normally injected into the balanced modulator is diode switched into the 455 kHz i.f. chain preceding the passband tuning block. This 455 kHz carrier signal is also gated for c.w. keying by a diode switch, Q503, which is controlled by a pulse shaping circuit, U500C, which provides for controlled rise and decay times during c.w. keying. The c.w. keying circuitry also activates a sidetone oscillator feeding the microphone preamplifier stage. This is provided so the VOX circuitry can also be used on c.w. for receive/transmit switching. The sidetone output is not used to generate a c.w. carrier. The VOX circuitry provides for separate "delay" control settings in the c.w. and s.s.b. modes.

On both s.s.b. and c.w. the output level essentially can be adjusted for QRP levels to full output. On s.s.b. this is accomplished by control of the microphone amplifier gain and on c.w. by circuitry which directly controls the r.f. carrier level via controlled biasing of the a.l.c. loop.

Metering provides for monitoring the a.l.c. level, using the same scale as for S readings on receive, and for direct reading of forward and reflected power levels as sampled at the output of the power amplifier.

Physical Construction

As was mentioned before, the KWM-380 is not a "light-weight" unit. But, the weight, besides deriving from a built-in power supply, comes about from absolutely solid construction. This is initially apparent from the front-panel controls and switches which are all well-dimensioned and of excellent quality. Taking a look at the back of the KWM-380 (see photo), one sees a massive cast aluminum heat sink which covers most of the rear of the unit. It wasn't measured, but I would easily estimate that it contains more square inches of cooling area than are contained on the heat sinks of some 1 kw conduction-cooled linear amplifiers. The back panel view also shows the nice layout of the connectors used, ranging from the antenna and a.c. power connectors on the left to the various connectors for linear amplifier control, speaker, key, etc., on the right side. The special connector in the center is for a special keyboard control option (described later).

To get at the inside of the KWM-380, one has to unscrew and slip off a complete wrap-around, perforated steel shell as can be seen in the rear view photo. Looking inside from a top view, one sees the power supply components on the left side and a multi-shielded compartment on the right side containing various PC boards. Very extensive use is made of ribbon cable interconnecting runs, which are long enough so any individual PC board can be removed for test/replacement without using extender cards. Although it is not too easy to point out, the single internal crystal oscillator which locks the frequency synthesizer is in its own separately shielded compartment on one of the front PC boards. The power amplifier is in a separately shielded compartment at the rear of the unit.

Taking a look at the exposed underside of the transceiver (see photo), one again sees the very extensive use of interconnecting cables between PC boards. The PC boards in themselves are quite interesting to study. They are of a high-quality glass epoxy type with fully plated-through holes, where applicable. Someone at Rockwell/Collins must have given "orders" that no component may be diagonally mounted on a PC board, and even disc ceramic capacitors have to be absolutely lined up at "attention" rather than being allowed to find their often rather natural, helter-skelter mounting state.

Seriously, however, the physical construction of the KWM-380 has to be rated as excellent. Any constructional feature that one looks at augurs for a very long service life for the unit along with reasonably easy service possibilities should a component or board require replacement. Not to detract from the foregoing

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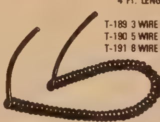

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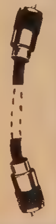

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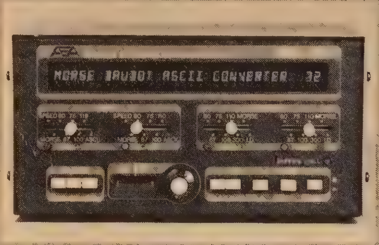

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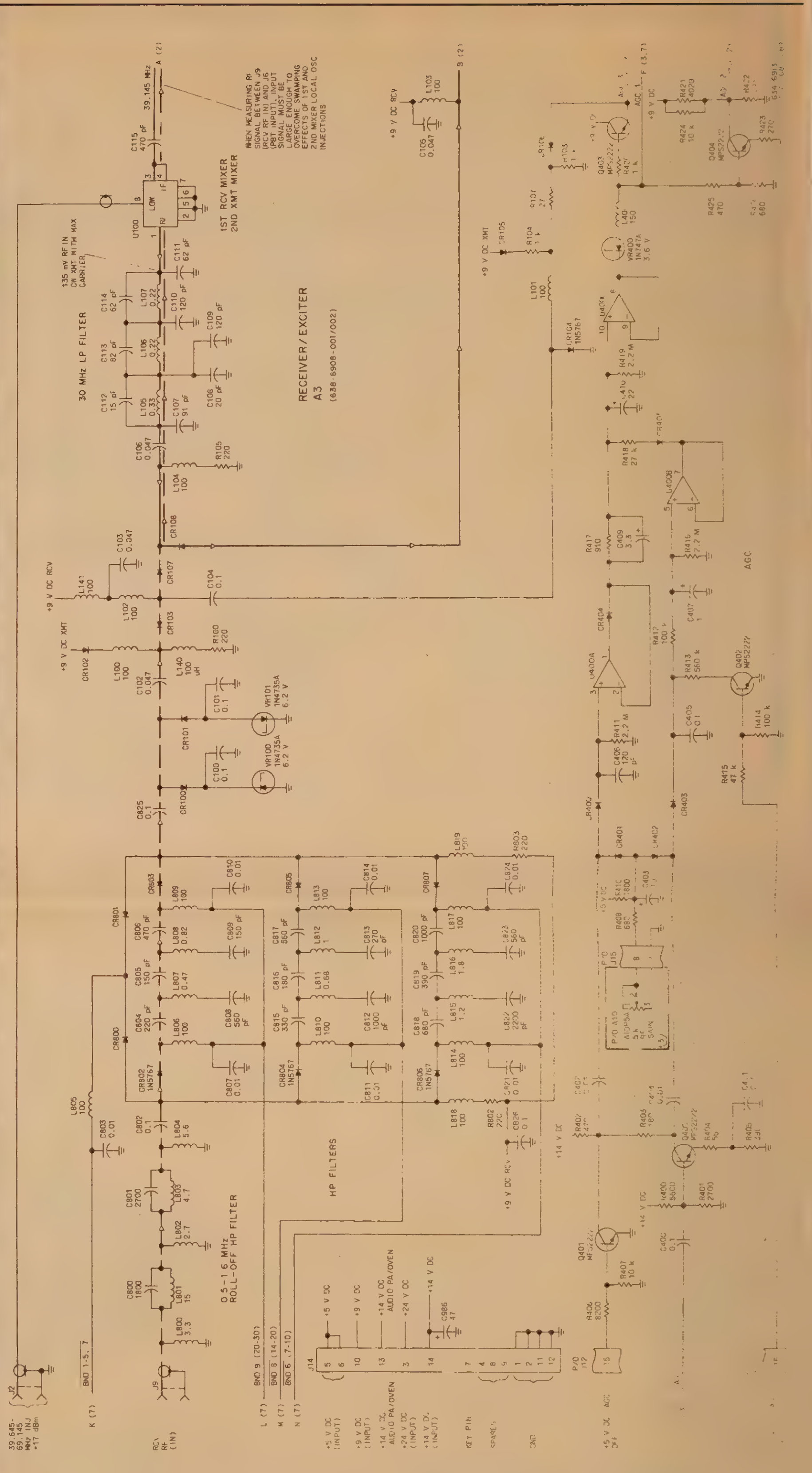

Fig. 3– Unusual "front-end" circuitry used in the KWM-380.

but yet to give the reader a complete picture of the KWM-380, one should mention two things. If one is going to use the KWM-380 under extreme environmental conditions, one has to take note of the perforated covering used. Obviously, operating placements subject to conditions such as a heavy salt-water-laden atmosphere give rise to possible problems. The other point—an extremely minor one to be sure—concerns the microphone input jack. It requires a special PJO-68 plug

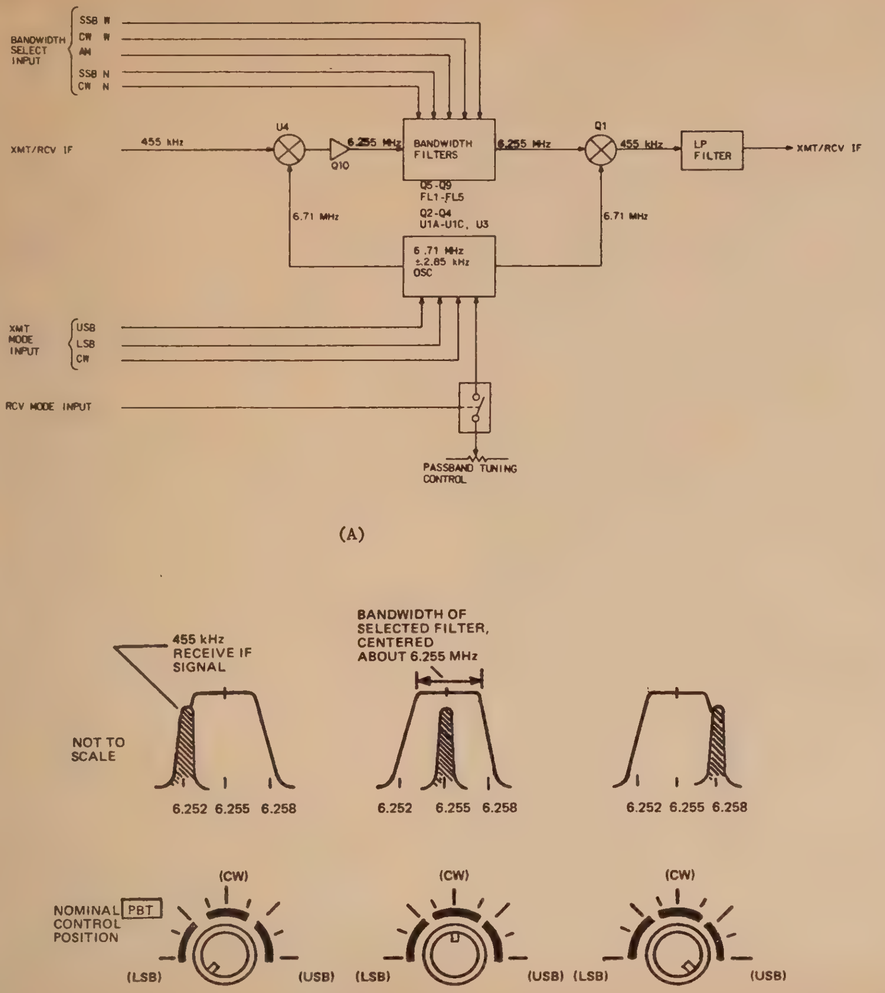

Fig. 4– (A) Basic passband tuning scheme used in the KWM-380. (B) An illustration of how an incoming signal is affected.

fairly common in military and commercial communications spheres but practically unused by radio amateurs. It has been the standard Collins plug for many years.

Test Results

Table I gives the claimed specifications for the KWM-380. To say the least after bench testing a unit, one should regard them as very conservative if not downright deliberately understated.

On the receive side, the KWM-380 greatly exceeded almost all of its claims. The sensitivity ranged around the 0.3 to 0.4 microvolt range for 10 dB STN/N ratio on s.s.b. throughout its tuning range. However, much more significant was the excellent dynamic range. The third order intercept point for 20 kHz spaced signals plotted consistently out in the range of + 14 to + 18 dBm (usually the latter). The synthesizer noise floor could hardly be found with the test equipment available. An educated estimate has to remain at better than – 100 dB.

The synthesizer design is undoubtedly a big part of the secret of the KWM-380's performance. Among other things, it allows the excellent shape factor of the s.s.b. filter to provide meaningful results in practice. The stability was only measured at room temperature rather than over the temperature range specified. A variation of only a few Hertz could be discerned over an operating period from turn-on to an hour or so later. I.f. and image rejection exceeded 70 dB. And, where did all the "birdies" and spurious responses go that one often accepts as being normal with amateur radio equipment designs? I got tired of searching for them. Perhaps there are a few of mini-microvolt proportions someplace, but certainly none are apparent. The S meter requires about 100 microvolts to indicate S9. This is more than the 50 microvolt standard for S9 frequently used, but of more importance is that the S meter response of the KWM-380 is linear within a few dB as signal levels change. So, one can provide a meaningful report to another station when testing antennas, audio devices, etc.

On the transmit side, there is no question that the KWM-380 will deliver a good 100 watts output over all of the amateur bands. It probably could be adjusted to provide 1½ times that power level and for normal s.s.b. operation would run just as cool. There is no fan included in the standard KWM-380, nor is one needed for normal c.w. or s.s.b. operation thanks to the huge PA heatsink on the rear of the unit. For AFSK RTTY operation over extended periods, there is an optional blower kit available which allows 100 watts average output with a 50% duty cycle to be maintained for one hour under keyed conditions! The power amplifier stage contains all sorts of protective circuitry, including the usual thermal and s.w.r. protection. It also contains a rather different forward power averaging circuit. This circuit senses forward power with a long time constant. If the forward power averages too high for too long, it activates a.l.c. circuitry to reduce the PA output in steps down to 20 watts. Output spurious products, including harmonics, were always below – 50 dB and sometimes ranged down to – 70 dB.

However, the most interesting aspect of the transmitted signal was the third-order IMD products. They measured – 32 to – 35 dB from PEP using a two-tone test signal. So, for all practical purposes, the KWM-380 IMD products are as good as any 100 watt class power amplifier using the ubiquitous 6146B tubes, and there is no tuning. The KWM-380 contains an internal power supply which can be strapped for input voltages ranging, in steps, from 105 to 250 volts. It can also operate directly from a 12–15 v.d.c. source. Using the latter, about 3 amperes are drawn in the receive mode and up to 18–20 amperes for 100 watt c.w./s.s.b. operation.

Operating Impressions

As was mentioned before, the transceiver is reset to 15.000.00 MHz when it is turned on. So, one first sees those digits appear rather impressively in their approximate 1 inch height above the main tuning knob. The group of push buttons above the knob controls the tuning rate, locks-out the tuning knob from changing the frequency which has been set, and can be used to synchronize the frequencies of the two built-in v.f.o.'s. Once one gets used to the rather strange symbols used for the tuning-rate buttons, it is rather easy to set up for operation, for example, on 21.195.00 MHz. One presses the ⌉ button for 1 MHz increments and turns the tuning knob less than a full turn until a reading of about 21 MHz appears. One then would normally press one of the ⌈ buttons for a 20 kHz/knob revolution rate to quickly finalize the frequency at 21.195.00 MHz. It takes longer to write about it or to read about it than it takes to accomplish it.

The **Mode** switch is used to select the desired transmit mode, and the **Passband**

Tuning/Selectivity control is set to the desired receive sideband and i.f. bandwidth. There is nothing more to set up or tune on the transceiver, and it is "ready to go" assuming that one has previously chosen VOX or MOX (PTT) mode, a.g.c. speed, speed processor in/out, etc. If one has to adjust an antenna tuner, the **Mode** switch on the KWM-380 can temporarily be set to **CW** and the **Mic/Carrier Level** control used to increase carrier output while the reversed power reading is observed and the antenna tuner is adjusted for minimum indication.

The tuning "feel" of the main tuning knob is extremely good. It feels slightly "heavy," yet turns easily. The other knobs are also very well dimensioned. For instance, the concentric **AF/RF Gain** control knobs are not the disaster found on some receivers. The **RF Gain** knob can readily be manipulated, which c.w. buffs should greatly appreciate.

If one set up the transceiver as mentioned for 21.195.00 MHz (with the v.f.o. switch at **A**) and then suddenly remembered a net on 3.897.50 MHz, it's a simple matter to set the v.f.o. switch to **B**, switch-in the appropriate tuning rate buttons, manipulate the main tuning knob a bit, and be set up on 3.897.50 MHz. One can then switch back and forth between the v.f.o. **A** and **B** settings for actual operation or for just monitoring purposes. The v.f.o.'s can also be set so one controls only the transmit frequency. In other words, half-duplex operation can be carried on between any two amateur bands. If one presses the **Sync** button, the two v.f.o. frequencies align themselves, yet one can be used to control transmit and the other to control receive. In fact, this can be used as a very sophisticated RIT option since the digital display will indicate the exact transmit/receive frequencies and one has independent tuning of each. One only has to remember that the KWM-380 will transmit in the s.s.b. mode as set by the **Mode** switch and receive l.s.b. or u.s.b. as set by the **Passband Tuning** (PBT) control. Of course, once one gets used to the very flexible dual-v.f.o. capability of the KWM-380, one wishes there were a half dozen more such v.f.o.'s so one could store various frequencies within a band and various general-coverage frequencies. In reality, such a provision is provided (see accessory items described next).

The impression that one gets as one uses the KWM-380 on receive both within and outside the amateur bands is its extremely "clean" performance. There is absolutely no hint of overload under the strongest weekend signal conditions, and its uniform sensitivity makes it a completely realistic general-coverage receiver as well as an amateur band transceiver. The "hang" a.g.c. action is excellent, being long enough in time constant to combat QSB, yet not being too delayed to provide full sensitivity once a signal drops out. The sensation of using the main tuning knob to continuously tune is quite something. When one tunes from an indicated 5.999.99 to exactly 6.000.00 MHz the first few times, one expects all sorts of relays to resound, etc. In fact, all is quiet and "bands" for the operator in a practical sense no longer exist.

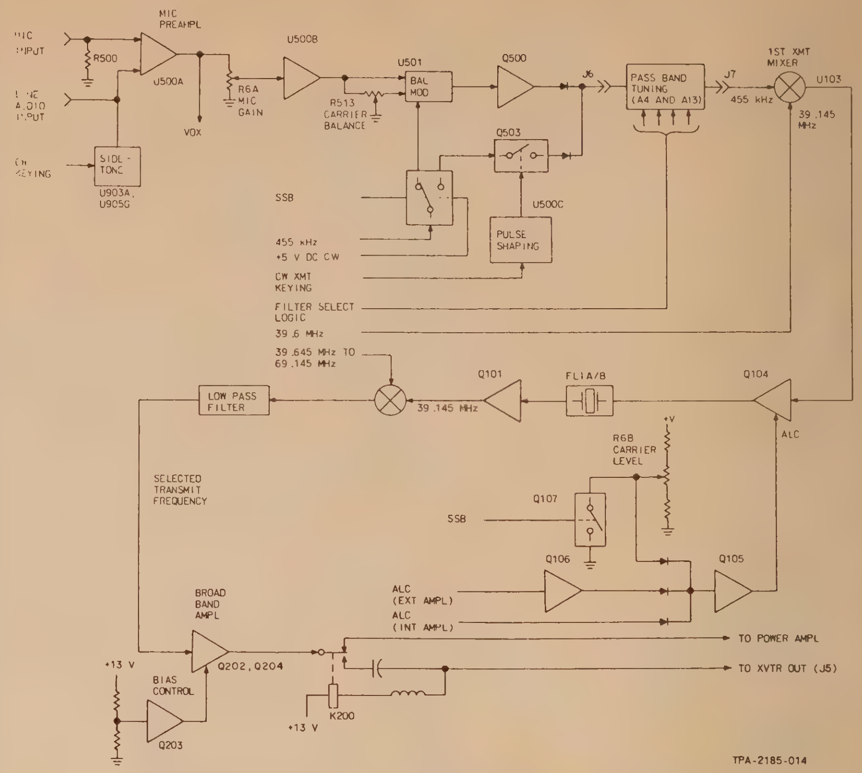

Fig. 5– Block details of the transmit chain in the KWM-380.

The audio quality produced by the front-panel-mounted speaker is perfectly adequate for normal station operation and obviates the need for any accessory speaker (none is offered for the KWM-380). The various optional filters provide for just about any selectivity problem. But, one must face the fact that the KWM-380 does not offer true variable bandwidth i.f. tuning nor a notch filter. Are they necessary? I would say no if one purchases the various optional filters available for the KWM-380, but of course, this does become a price question.

On transmit the KWM-380 consistently produced comments regarding its good audio quality. It has signal "punch" but with a "clean" sounding audio, used either in its basic configuration or with its optional speech processor (described under accessories). Perhaps one reason for this is its shaped frequency response of 300 to 2400 Hz on transmit with only a few dB's level variation within that passband. Another reason is undoubtedly the sophisticated a.l.c. system used, which keeps the average to peak level power level output closely linked. VOX operation was very smooth. C.w. operation was not tried as extensively as s.s.b. operation, but the KWM-380 appears to be as excellent a c.w. transceiver as an s.s.b. one. The separate **C.W. Delay** control on the VOX circuitry is very handy to set up for semi-QSK operation on c.w. Used for normal s.s.b. or c.w. operation, the transceiver will run "cool" indefinitely. There is no cooling needed (except for extended RTTY operation), so operation is perfectly quiet.

Accessory Items

There is an extensive line of optional and accessory items available for the KWM-380. The internal mount optional items include WARC conversion, various i.f. filters, a noise blanker, a speech processor, and a control interface. The outboard accessory items range all the way from different types of microphones and headphones to a blower kit for the heatsink. Some items have been mentioned in passing before, so only a few will be covered in detail.

The WARC conversion consists of replacing an ROM IC on a PCB within the transceiver. The conversion requires the removal of some 39 screws to get at the required PC board. Some versions of the PC board have the IC socketed and some do not. So, the conversion either can be extremely simple or require a bit of soldering. In any case, the conversion will result in the frequency coverage change shown in Table II. Note that the conversion not only provides for WARC coverage, but also expands the 80–15 meter bands for MARS transceive coverage.

The optional speech processor available for the KWM-380 is of a completely new design and a patent is pending on it. It is an audio processing type, but hardly a simple compressor or clipper. In its literature, Collins concedes that the gener-

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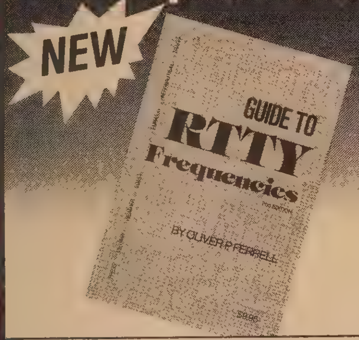

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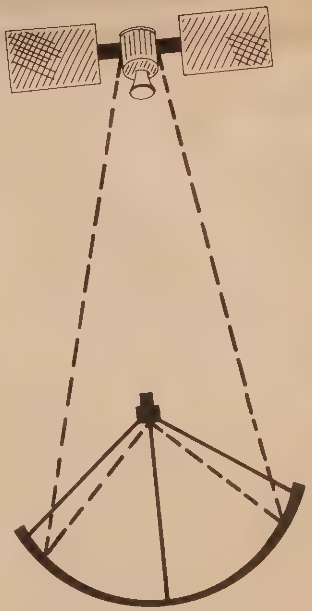

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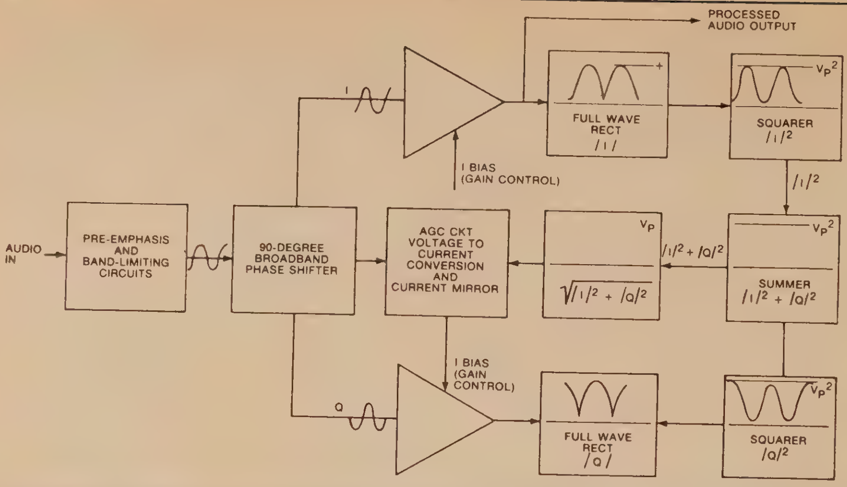

Fig. 6– Block diagram of the circuit functions in the new type of AF speech processor which is an option for the KWM-380.

al consensus is that r.f. speech processing provides the best results, but with some undesirable harmonic distortion and r.f.i. as inherent in any clipping action. They claim their method is as good as r.f. processing without any of its disadvantages. A block diagram of the processor is shown in fig. 6. The actual physical unit is a PC board measuring about 4¼″ × 4½″ and contains some 13 IC's and 8 transistors. A later article may explore the concept of this item in depth, but the general idea, as shown in fig. 6, is that the microphone signal is divided into two 90 degree phase shifted signals which are detected and recombined and produce a d.c. signal proportional to the peak signal at the detectors. The gain of the phase amplifiers is regulated to produce an a.f. signal with *peaks* maintained at a preset threshold. Harmonic distortion is claimed to be about 1½% across the 300–3000 Hz range for about 15 dB of voice processing. From tests made with the KWM-380 there is no doubt that the optional processor does add something in the order of 4 to 6 dB of apparent increased signal intelligibility with no apparent distortion. It works and works extremely well, but whether it is the ideal solution to the question of speech processing remains open. In any case, it is an outstanding advance in audio-type processing.

The Control Interface option is innocuous sounding, but it adds tremendous versatility to operation of the KWM-380. The option itself consists of a PC board assembly and a connector which is for inter-connection with a user-supplied external key pad (any sixteen button, two-out-of-eight device) or possibly a home computer with parallel interface capability. In any case, the interface allows for the digital selection, storage, or recall of frequencies (the storage/recall capability being either 10 or 11 frequencies, depending upon whether the WARC option is installed).

Using a key pad, the operating frequency can be selected from either the main tuning knob or the key pad. One simply enters the frequency desired digit by digit. The frequency being entered on the key pad is displayed, but the transceiver's operating frequency is only changed when an "enter" key is depressed. The interface PC board contains memory locations for 10 (or 11) frequencies inde-

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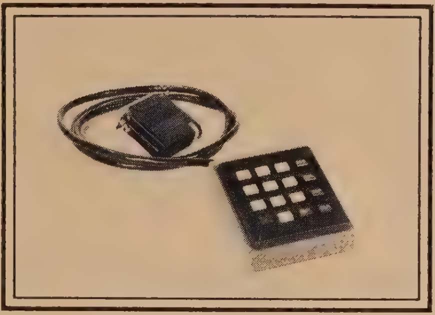
CIRCLE 24 ON READER SERVICE CARD

Band (Meters)	Without SB 10 (MHz)	With SB 10 (MHz)
160	1.8 to 2.0	No change
80	3.5 to 4.0	3.25 to 4.25
40	7.0 to 7.3	6.75 to 7.55
30	—	10.10 to 10.15
20	14.0 to 14.35	13.75 to 14.60
16	—	18.060 to 18.170
15	21.00 to 21.45	20.75 to 21.70
12	—	24.890 to 24.990
10	28.0 to 29.7	No change

Table II– Transceive frequency coverages of the KWM-380 when the SB 10 WARC option ROM is installed.



The KWM-380 can be remotely controlled by a key pad such as the one shown here (or a similar one supplied by the user). A control interface option has to be installed in the KWM-380 to use the key pad, but then one will have key-pad control of frequency entry, storage, and recall. If one imagines the key pad on the right of the front-panel view of the KWM-380 showing the microphone on the left, one has a completely integrated, automated h.f. station.

pendent of the two v.f.o. registers. To store any frequency, it is entered by keyboard selection and addressed to a desired memory location (e.g., 1, 2, 3, etc.). The transceiver can continue on its tuning knob selected operating frequency, if desired, during the process. Or, the current operating frequency can be stored by a store and memory location key pad command. Recalling a frequency consists of pressing a recall key and a memory location. This action loads the stored frequency into the v.f.o. register in use (A or B) and sets the transceiver's operating frequency to the recalled frequency. One can also use key pad commands to manually step the transceiver through each memory starting from the present memory location in use. Blank or cleared memory locations are skipped during the manual stepping process.

The key pad frequency control option obviously adds all sorts of operating possibilities to the KWM-380, ranging from serious DX chasing across several bands if desired (remember, there is no bandswitch) to switching to a news program during a boring net session. Removing power from the transceiver will clear all memory locations.

Manual and Service Notes

An operating manual does, of course, come with the KWM-380, and it contains very clear, practical information for getting the unit into operation. It has a multitude of photos and illustrations all directed towards telling the operator how to hook up the transceiver, which controls to turn for various functions, etc. It also contains a limited amount of information on maintenance and some PC board interconnection data, so if a PC board is exchanged, one can understand which interconnecting cables are involved.

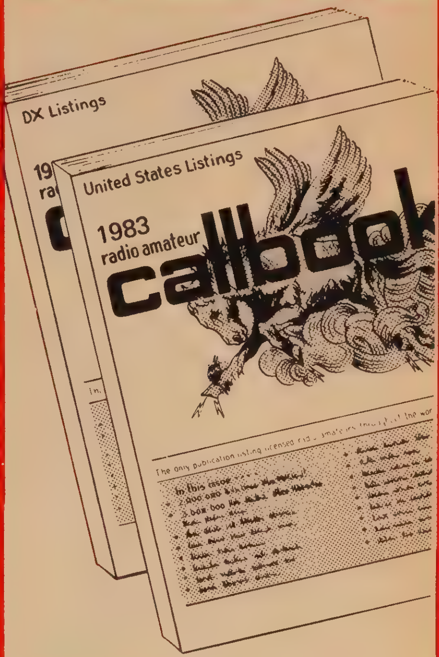
A separate, quite elaborate service manual is available for about $40. This manual is extremely complete with thorough information on PC board layouts, schematic diagrams, alignment and test data, etc. Complete parts data is given along with the name and address in the U.S. of the manufacturer of every component used (except common resistors, capacitors, hardware, etc.). The manual also contains a complete set of service bulletins issued for the KWM-380 and a postcard reply form which will put the purchaser on automatic distribution for all future service bulletins as long as the KWM-380 remains in production. Quite a few such service bulletins were issued up to January 1981. The last one contained in the manual reviewed was dated August 1981 and was only information on WARC conversion.

Dealer and factory service for the KWM-380 is available and there is a one-year warranty. Those restricted to certain APO/FPO addresses, however, might note that the KWM-380 is too large (with packing) for Parcel Post shipment, and freight shipment must be used.

Summary

The KWM-380 is an outstanding piece of equipment. It offers extremely sophisticated operating capabilities using state-of-the-art technology, but without a front panel so cluttered with knobs, push buttons, and switches that one misses out on the fun of operating while trying to figure out how to operate a transceiver. It is not inexpensive. But, its design concept is sound, and, as Rockwell/Collins is willing to put in black and white, "No yearly model changes. As circuit improvements and modifications are made to the KWM-380, its style does not become obsolete." ▣

1983 CALLBOOKS



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CIRCLE 114 ON READER SERVICE CARD

Awards

a monthly feature by
A. EDWARD HOPPER, W2GT

NEWS OF CERTIFICATE AND AWARD COLLECTING

The November Story of the Month as told by Paul is:

Paul I. Wells, W4LQF
All Counties #323, 4-22-81

"I was licensed as W5HRV in 1938 at Denison, Texas, my old home town. As a National Guardsman, I operated and trained personnel in the use of Army field radio equipment during the pre-WW II years. Much of this equipment was of quite old design—possibly WW I, or at best post-WW I.

"I was mobilized with the 36th Signal Company, 36th Infantry Division, Texas National Guard for WW II training and service. Overseas service included Morocco, Algeria, Italy, France, Germany, and Austria. Ended WW II as Commanding Officer, 36th Signal Company.

"Remained in the Army after WW II and saw further service as Military Advisor to the Office of the Chief Signal Officer, Korean Army (1950–1952); and Planning Officer, Headquarters, U.S. Army Communications Zone, Orleans, France (1955–1959). Saw service with the military expedition to Lebanon (July–November 1958). All Army service was with the Signal Corps. Retired from military service in December 1960. Was employed as a Department of the Army Civilian from 1962 through March 1974.

"Operated my amateur station as F7AT while on duty in France from 1955–1959. Made my first application for USA-CA-500 through 1500 in March 1979.

"Married my wife, Louise, on January 4, 1936, and we have one son, Paul R. Wells, WA3HFL, of Newark, Delaware, who has two sons, Paul and Kurt.

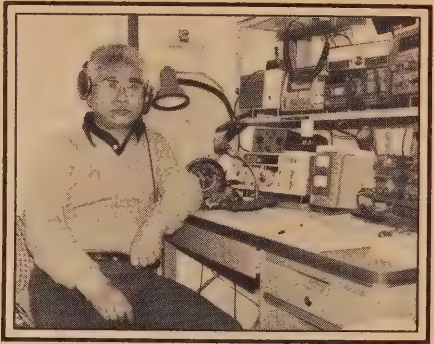
"Am life member of the ARRL, QCWA member #9516, member of the Army MARS System, and life member of the VFW.

"Many thanks to *CQ* and all the wonderful County Hunters."

Awards Issued

Vic Fitzgerald, WB0LOU, waited until he had them All and picked up USA-CA-500 through USA-CA-3000 endorsed All 2X S.S.B., All 20, All Mobiles; and All Counties endorsed All 2X S.S.B., All 20.

Jim Farner, KK5P, also waited until he had them All and acquired USA-CA-500 through All Counties endorsed All S.S.B., All 14, All Mobiles.



Yasu, JH8GWW, winner of USA-CA-500 #1746 endorsed All 10 meter S.S.B., in his well-equipped radio room.

Antenna of JH8GWW at QTH 80 meters above sea level.

Bill Bell, KM4W (ex-WD4DAI), stayed in style by also waiting until he had them All to obtain USA-CA-500 through USA-CA-3000 endorsed All A-3, All 20, All Mobiles, and All Counties endorsed Mixed.

Dan Hammell, WA9EZT, claimed USA-CA-500 through USA-CA-3000 endorsed All S.S.B., All 75.

Ted Long, K0UQV, added to his collection USA-CA-2500 endorsed Mixed.

Bill Webb, WB1GOO, found time to do his paperwork to send for USA-CA-500 through USA-CA-2500 endorsed All S.S.B., All 14, All Mobiles.

Angelo Ferrari, I2PHN, qualified for USA-CA-500 through USA-CA-2500 endorsed All 2X S.S.B., All 20, All Mobiles. His 500 was #20 to Italy, his 1000 was #3, his 1500 and 2000 were #2, and his 2500 was #1 to Italy.

Roger Hansen, KL7HFQ (ex-WA7FHY), collected USA-CA-2000 endorsed Mixed (#2 to Alaska).

John Kray, KA2CNG, added USA-CA-2000 endorsed Mixed to his growing collection.

Inati Alcorta Goni, EA2IA, gained USA-CA-1000 endorsed Mixed (#1 to EA).

USA-CA-500 Certificates endorsed Mixed went to:

Chiaki Watanbe, JA2TK (#44 to Japan, #7 to JA2).

Tado Shimoichi, JA1WPX)#45 to Japan).

USA-CA-500 Certificates endorsed All C.W. were won by:

Horst Kampa, DJ8TJ.

James L. Jolly, W4YDL.

Dalbeni Romano, I2YJO, got USA-CA-500 endorsed All Phone.

Special Honor Roll
All Counties

#390 Roy Victor Fitzgerald, WB0LOU 7-12-82.
#391 James E. Farner, KK5P 7-23-82.
#392 William E. Bell, KM4W 7-31-82.

Awards

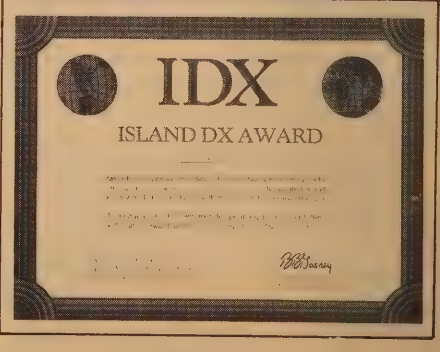
Island DX Award: This revised award is sponsored by the Whidbey Island DX Club and is available to licensed amateurs and shortwave listening stations worldwide. (This award is not to be confused with the Islands-on-the-Air Awards issued by Geoff Watts, 62 Bellmore Road, Norwich, NOR 72T, England.)

Awards are issued for 2X S.S.B., 2X C.W., 2X RTTY, and 2X SSTV, as well as Mixed and Single Band.

Fifty (50) IDX Islands are required for the basic award. Endorsements are given in increments of 50 islands, up to and including the maximum number of islands possible.

All DXCC countries which are bonafide "islands" are the only qualifying contacts. A special IDX Listing can be obtained for an s.a.s.e. or s.a.e. and IRC.

To be valid, all contacts must be made *after* October 1, 1977. To apply, prepare a list of contacts in prefix order. *Please*



IDX

ISLAND DX AWARD

Island DX Award.

P.O. Box 73, Rochelle Park, NJ 07662

MAINTENANCE

Without extensive test equipment, only a limited amount of maintenance can be performed. The following information lists the replaceable fuses and lamps, and guides in determining general functional areas in which a detected malfunction may be located. Only a multimeter and rf voltmeter are required for the tests.

replaceable fuses and lamps

Primary power (located on rear panel) — 8 A, AGC for 110 V; 4 A, AGC for 220 V.

13-volt supply (two fuses located on power supply card under chassis) — 2 A, AGC.

Panel meter lamps (wired into holder at top rear of meter) — T1 3/4, 14 V, 100 mA, type 7373.

front-panel troubleshooting

INDICATION	POSSIBLE CAUSE	TROUBLESHOOT
Rapid beeping in speaker	Synthesizer unlocked.	Check 5-, 9-, and 24-V supply outputs. Check synthesizer output levels.
No audio output	Receiver audio circuits malfunctioning.	Check 13-V supply fuses.
	Synthesizer outputs weak/absent.	Check synthesizer output levels.
	High loss in low-pass filters or antenna transfer relay.	Connect receiver antenna to RCV IN jack on rear panel. (Bypasses antenna transfer relay and low-pass filters.)
No rf output	Power amplifier circuits malfunction.	Check for 3 V rms (at full carrier gain) at J1 on rcvr-extr board. Check synthesizer output levels.

synthesizer output levels

Refer to figure 10 for connector locations on rcvr-extr board. The following measurements are made with an rf voltmeter.

455 kHz (J10) in SSB receive — greater than 50 mV rms.

454.2 kHz (J11) in CW receive — greater than 50 mV rms.

39.6 MHz (J3) in receive or transmit — approximately 0.5 V rms.

1st mixer injection (J2) in receive or transmit — approximately 0.5 V rms.

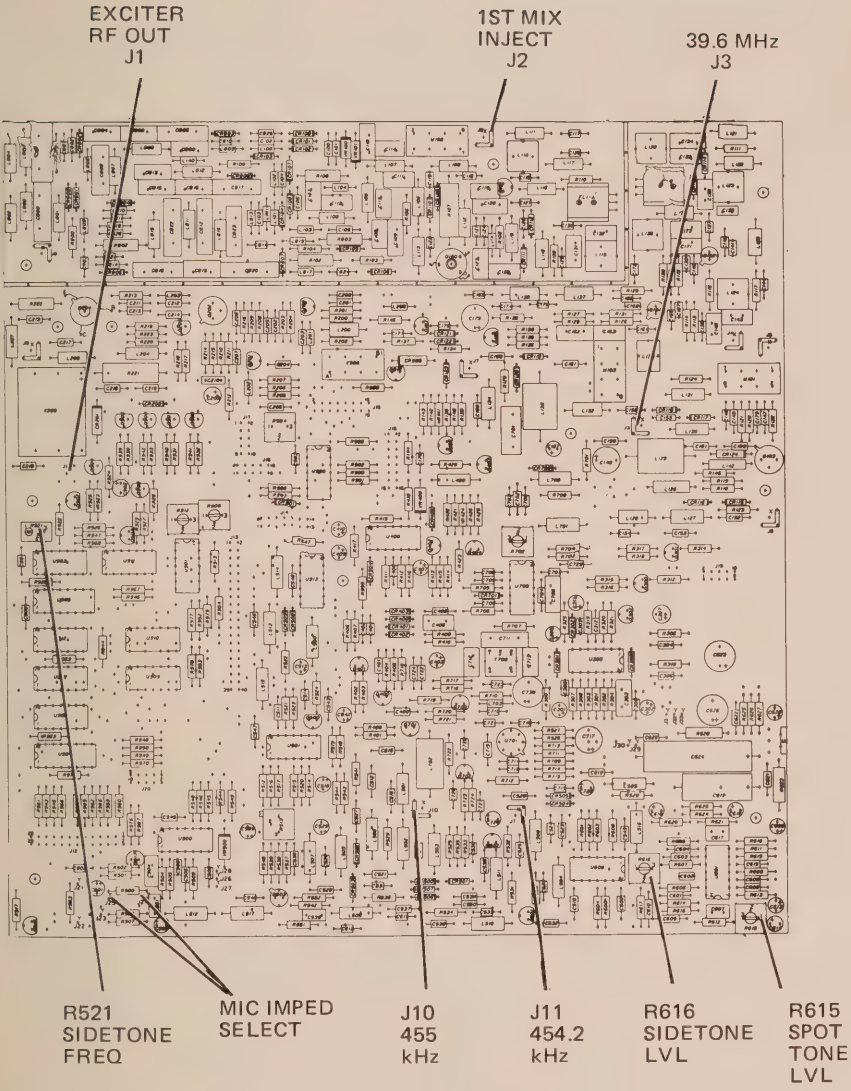
receiver-exciter sidetone and spot potentiometer adjustments

Refer to figure 10 for locations of sidetone frequency and level and spot tone level potentiometers. These potentiometers may be adjusted to the level or frequency desired by the operator.

DO NOT MAKE ANY OTHER ADJUSTMENTS ON THE RECEIVER-EXCITER BOARD WITHOUT THE INSTRUCTIONS AND TEST EQUIPMENT SETUP GIVEN IN THE KWM-380 SERVICE MANUAL.

microphone impedance selection

The KWM-380 is factory wired for a low-impedance microphone. A high-impedance microphone may be used, however, by removing a 270-ohm resistor and replacing it with a value between 10 and 47 kΩ that approximately matches the microphone impedance. Refer to figure 10 for the resistor location. Use caution in removing and installing the resistors. Do not apply heat from the soldering iron to the circuit board pads longer than necessary. Excessive heat can damage the circuit board.

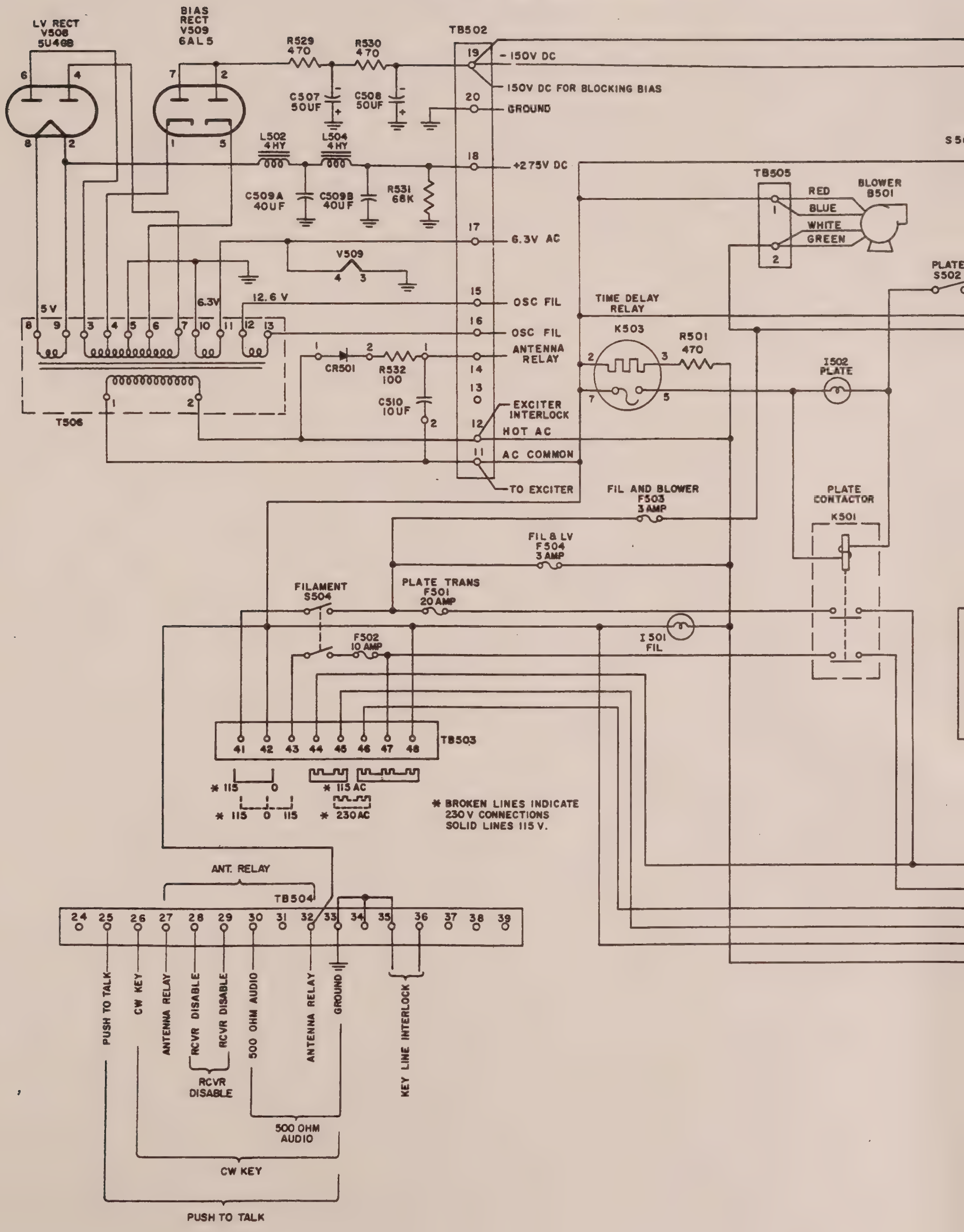


TPA-1683-019

Receiver-Exciter Connectors and Adjustments Locations
Figure 10

JN-402
mcN-567

LOW VOLTAGE AND BIAS SUPPLY



SN-402
MCN-567

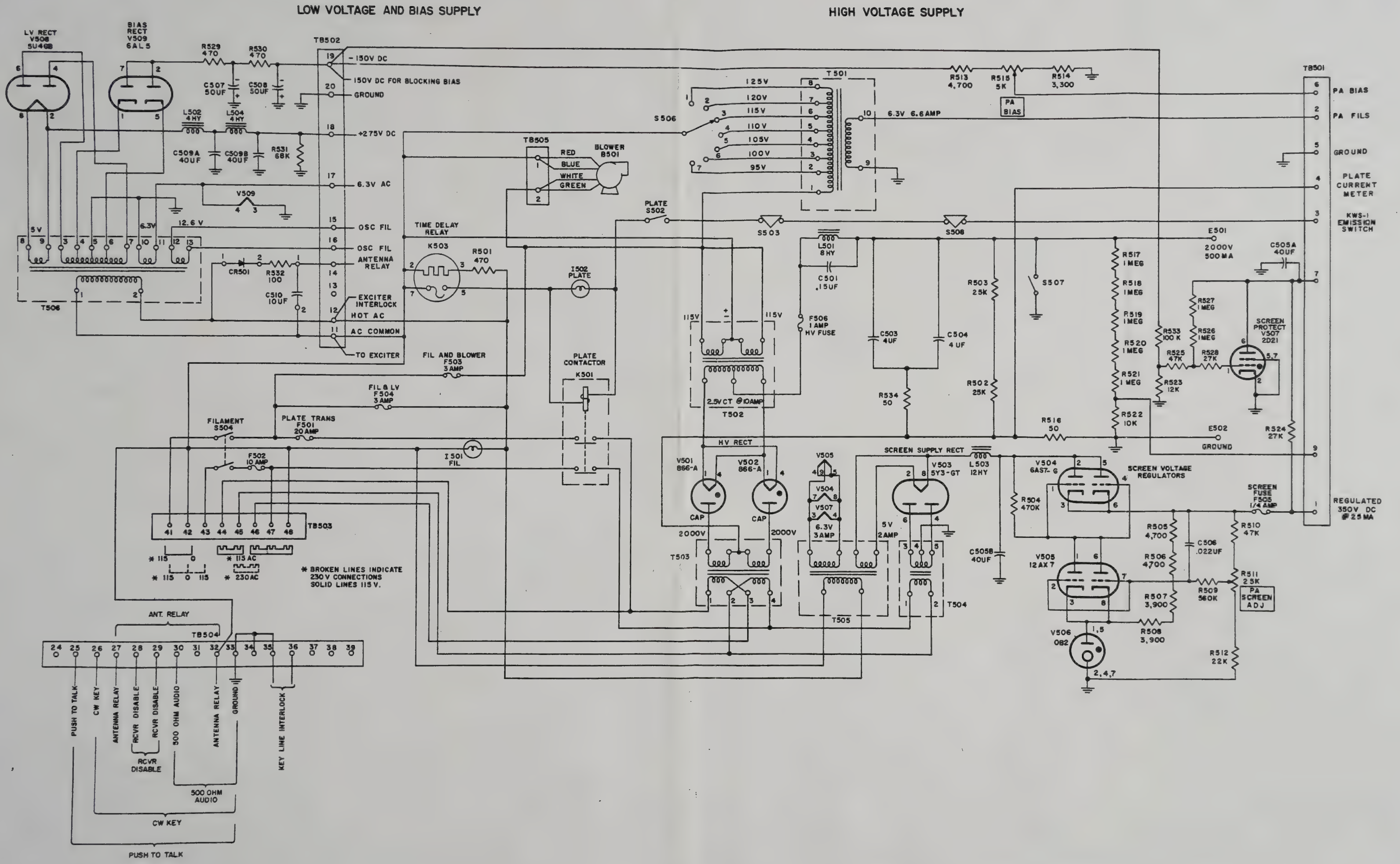


Figure 7-2. Power Supply, Complete Schematic Diagram

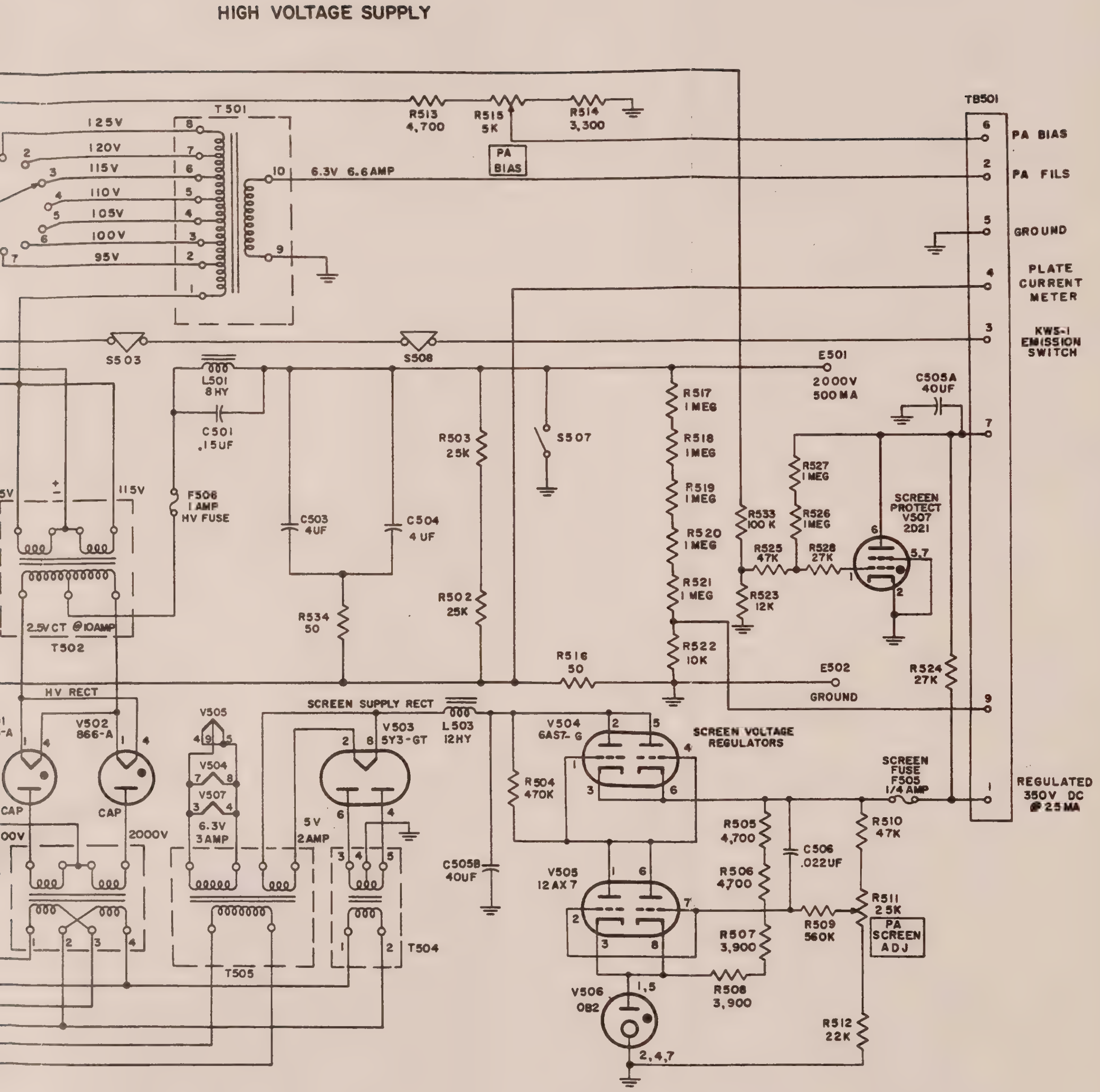
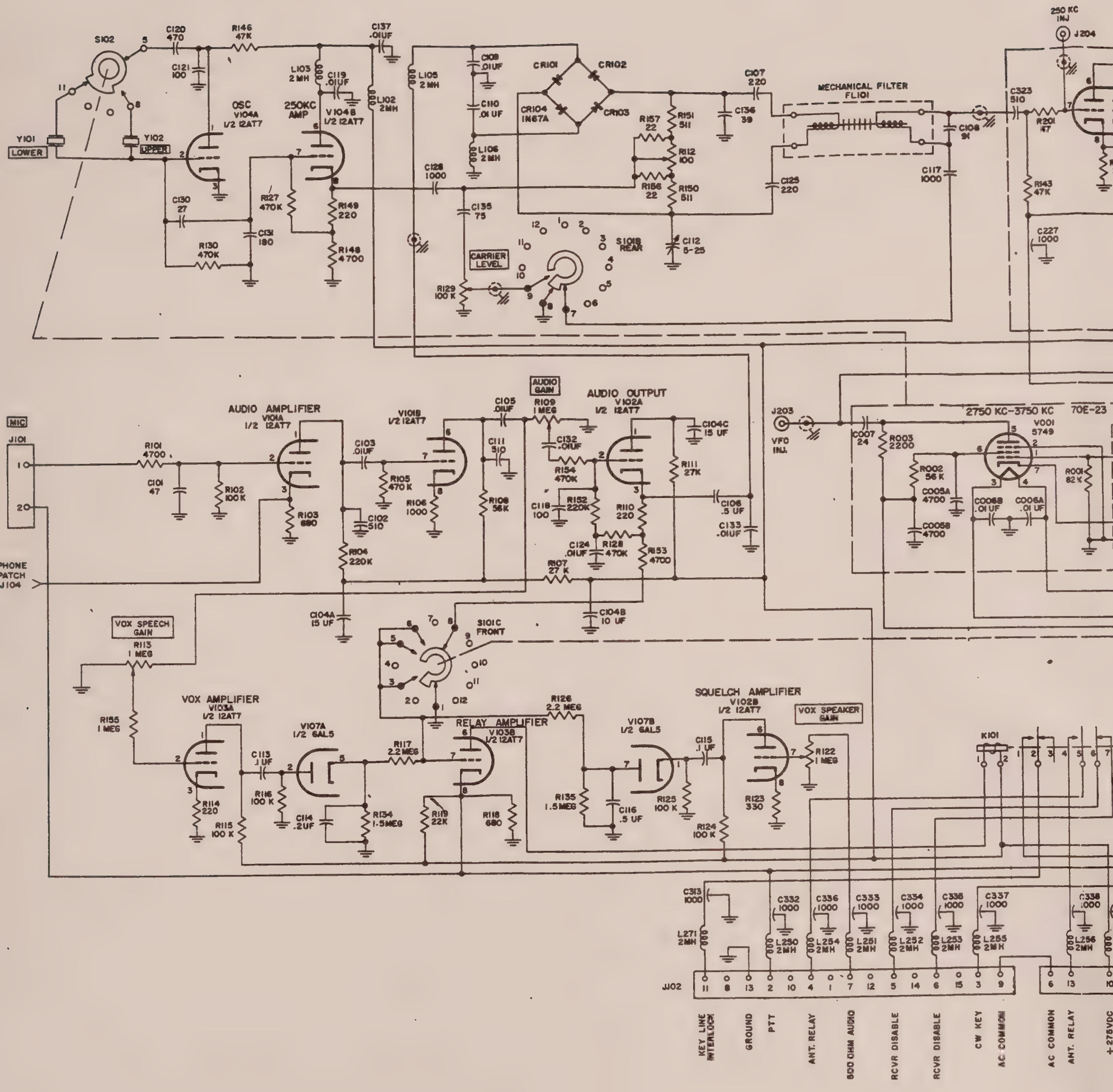


Figure 7-2. Power Supply, Complete Schematic Diagram



S102
C120 470
R146 47K
C121 100
C137 .01UF
L103 2MH
C119 .01UF
L102 2MH
L105 2MH
C109 .01UF
C110 .01 UF
L106 2MH
CR101
CR102
CR104 IN67A
CR103
R157 22
R151 511
R112 100
R156 22
R150 511
C107 220
C136 39
MECHANICAL FILTER FL101
C108 91
C125 220
C117 1000
C112 5-25
Y101 LOWER
Y102 UPPER
OSC V104A 1/2 12AT7
250KC AMP V104B 1/2 12AT7
C130 27
C131 180
R130 470K
R127 470K
R149 220
R148 4700
C128 1000
C135 75
CARRIER LEVEL
R129 100 K
S101B REAR
250 KC INJ
J204
C323 510
R201 47
R143 47K
C227 1000
MIC
J101
R101 4700
C101 47
R102 100K
AUDIO AMPLIFIER V101A 1/2 12AT7
R103 680
C103 .01UF
R105 470K
V101B 1/2 12AT7
R106 1000
C102 510
R104 220K
C105 .01UF
C111 510
R108 56K
AUDIO GAIN
R109 1 MEG
C132 .01UF
R154 470K
AUDIO OUTPUT V102A 1/2 12AT7
C104C 15 UF
R111 27K
C118 100
R152 220K
R110 220
C124 .01UF
R128 470K
R153 4700
C106 .5 UF
C133 .01UF
R107 27 K
C104A 15 UF
C104B 10 UF
PHONE PATCH J104
J203 VFO INJ.
C007 24
R003 2200
2750 KC-3750 KC 70E-23
V001 5749
R002 56 K
C005A 4700
C005B 4700
C006B .01 UF
C006A .01 UF
R001 82 K
VOX SPEECH GAIN
R113 1 MEG
S101C FRONT
R155 1 MEG
VOX AMPLIFIER V103A 1/2 12AT7
R114 220
R115 100 K
C113 .1 UF
R116 100 K
V107A 1/2 6AL5
C114 .2UF
R134 1.5MEG
R117 2.2 MEG
RELAY AMPLIFIER V103B 1/2 12AT7
R119 22K
R118 680
R126 2.2 MEG
V107B 1/2 6AL5
R135 1.5MEG
C116 .5 UF
C115 .1 UF
R125 100 K
SQUELCH AMPLIFIER V102B 1/2 12AT7
VOX SPEAKER GAIN
R122 1 MEG
R123 330
R124 100 K
K101
C313 1000
L271 2MH
C332 1000
L250 2MH
C336 1000
L254 2MH
C333 1000
L251 2MH
C334 1000
L252 2MH
C335 1000
L253 2MH
C337 1000
L255 2MH
C338 1000
L256 2MH
J102
KEY LINE INTERLOCK
GROUND
PTT
ANT. RELAY
500 OHM AUDIO
RCVR DISABLE
RCVR DISABLE
CW KEY
AC COMMON
AC COMMON
ANT. RELAY
+275VDC

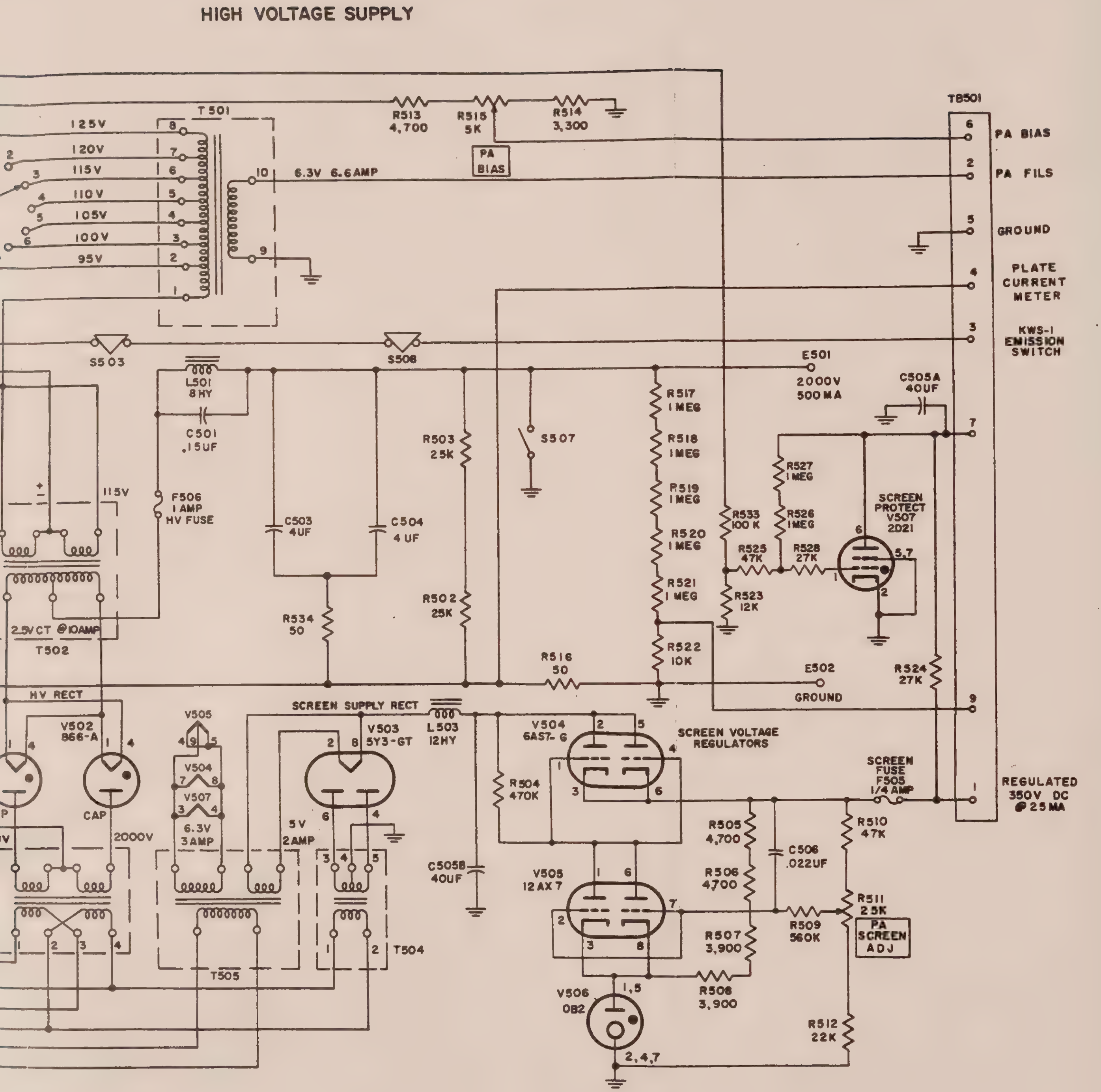
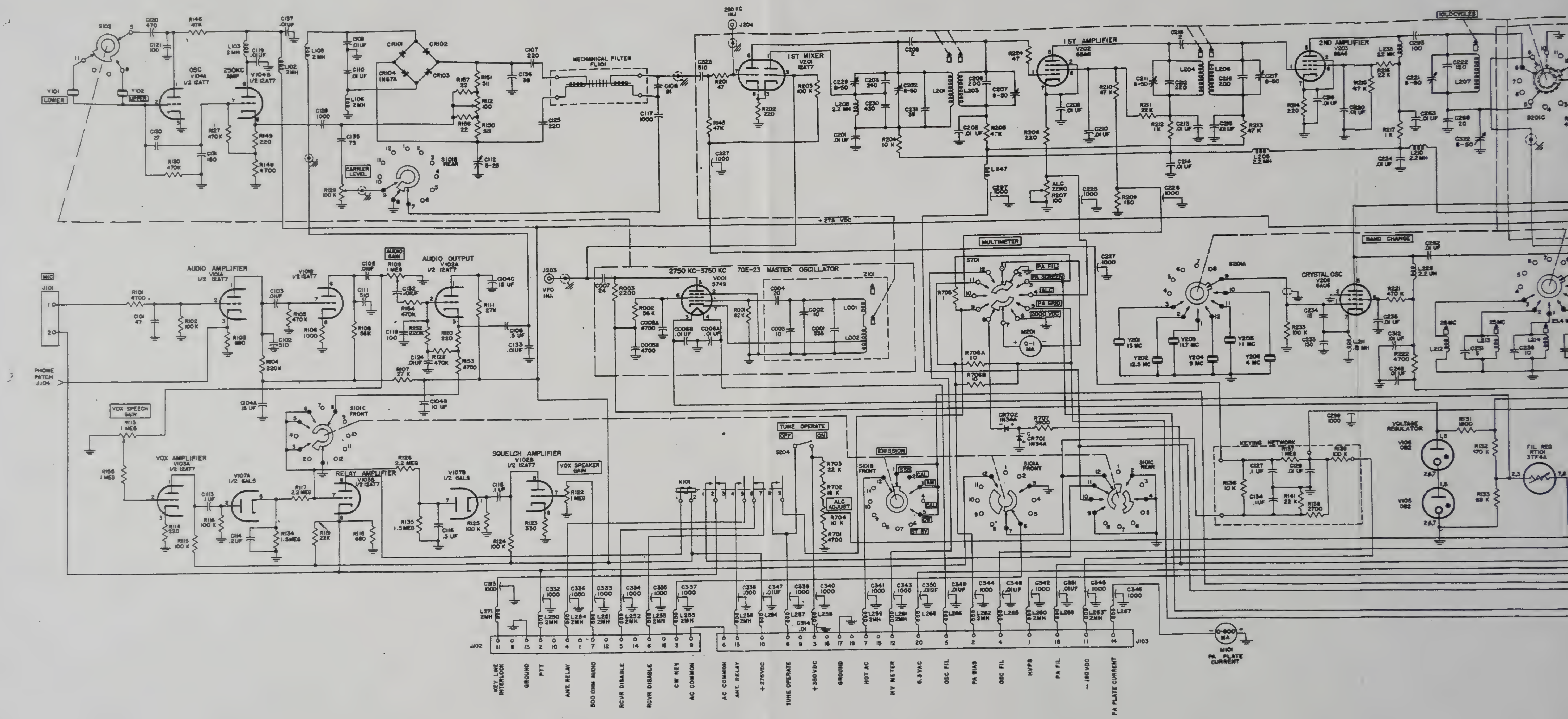
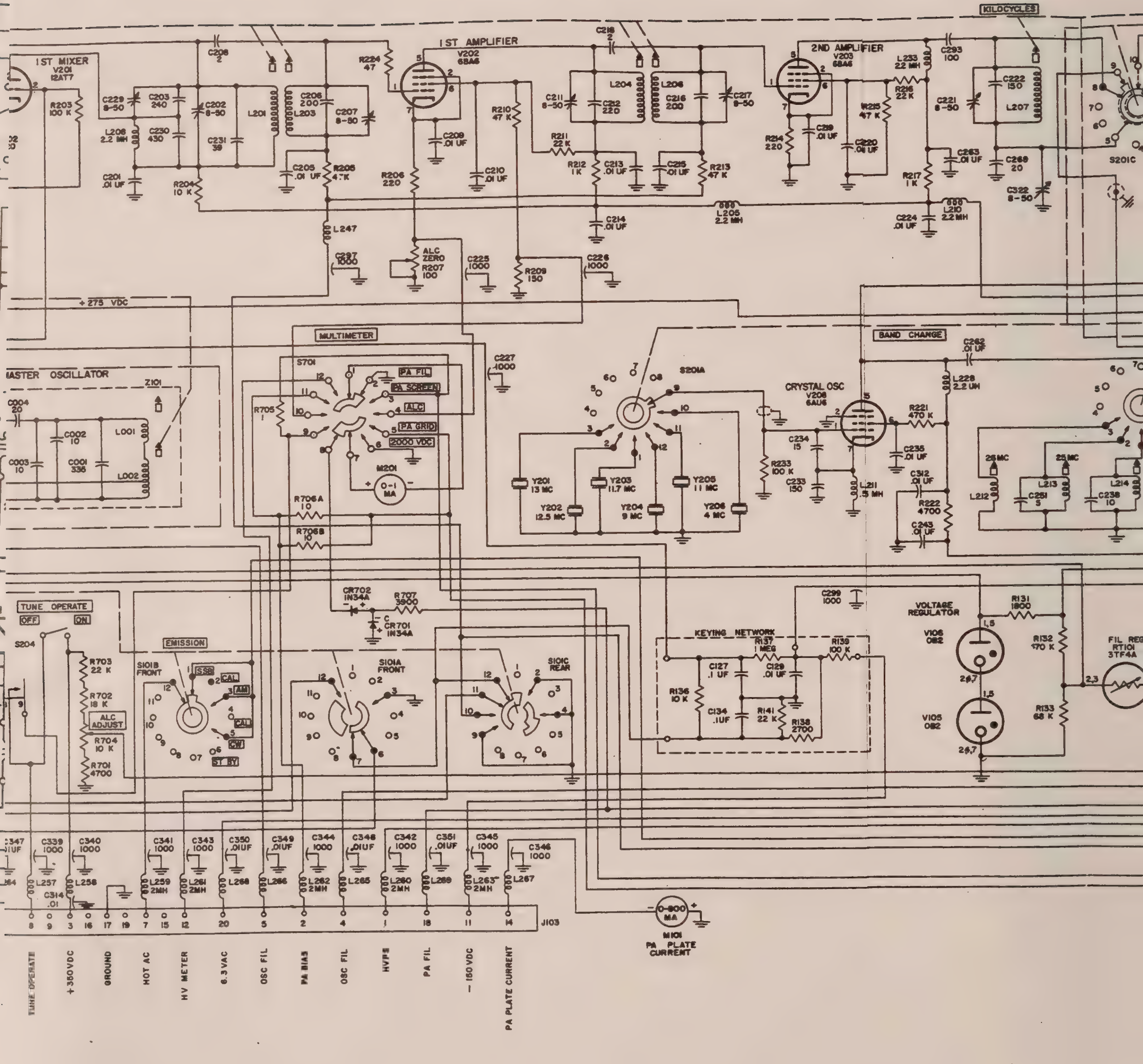
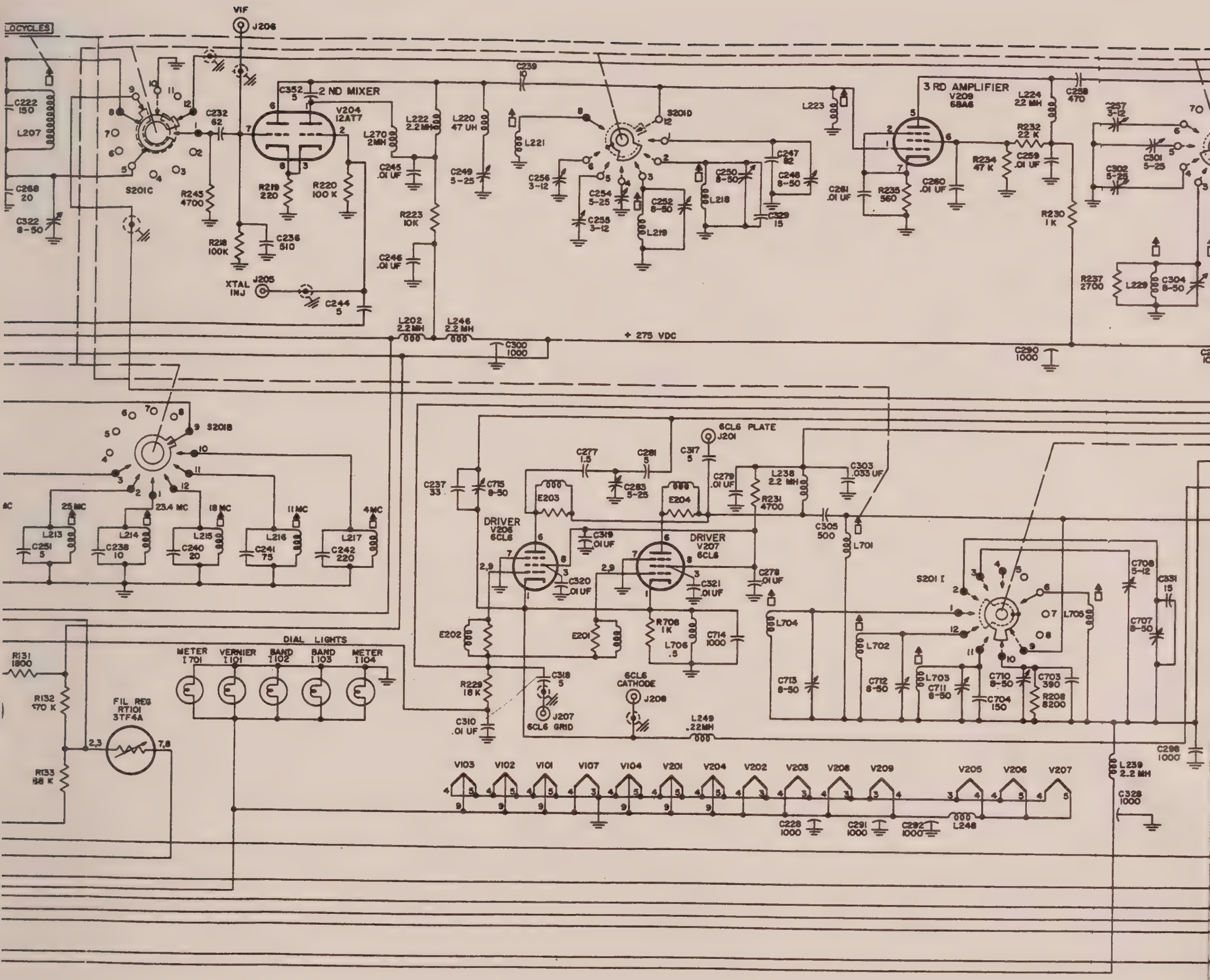


Figure 7-2. Power Supply, Complete Schematic Diagram


Y101 LOWER
Y102 UPPER
S102
OSC V104A 1/2 12AT7
250KC AMP V104B 1/2 12AT7
CARRIER LEVEL
S101B REAR
MECHANICAL FILTER FL101
250 KC INJ J204
1ST MIXER V201 12AT7
1ST AMPLIFIER V202 6BA6
2ND AMPLIFIER V203 6BA6
KILOCYCLES
S201C
ALC ZERO R207 100
+275 VDC
MIC J101
PHONE PATCH J104
AUDIO AMPLIFIER V101A 1/2 12AT7
V101B 1/2 12AT7
AUDIO GAIN
AUDIO OUTPUT V102A 1/2 12AT7
VFO INJ. J203
2750 KC–3750 KC 70E-23 MASTER OSCILLATOR
V001 5749
Z101
MULTIMETER
S701
PA FIL
PA SCREEN
ALC
PA GRID
2000 VDC
M201 0-1 MA
BAND CHANGE
S201A
CRYSTAL OSC V206 6AU6
Y201 13 MC
Y202 12.5 MC
Y203 11.7 MC
Y204 9 MC
Y205 11 MC
Y206 4 MC
VOX SPEECH GAIN
S101C FRONT
VOX AMPLIFIER V103A 1/2 12AT7
V107A 1/2 6AL5
RELAY AMPLIFIER V103B 1/2 12AT7
V107B 1/2 6AL5
SQUELCH AMPLIFIER V102B 1/2 12AT7
VOX SPEAKER GAIN
K101
TUNE OPERATE
OFF
ON
S204
ALC ADJUST
EMISSION
S101B FRONT
SSB
CAL
AM
CW
CAL
ST BY
S101A FRONT
S101C REAR
CR702 1N34A
CR701 1N34A
KEYING NETWORK
VOLTAGE REGULATOR
V106 OB2
V105 OB2
FIL RES RT101 3TF4A
J102
11 KEY LINE INTERLOCK
8
13 GROUND
2 PTT
10
4 ANT. RELAY
1
7 500 OHM AUDIO
12
5 RCVR DISABLE
14
6 RCVR DISABLE
15
3 CW KEY
9 AC COMMON
J103
6 AC COMMON
13 ANT. RELAY
10 +275VDC
8 TUNE OPERATE
9
3 +350VDC
16
17 GROUND
19
7 HOT AC
15
12 HV METER
20 6.3 VAC
5 OSC FIL
2 PA BIAS
4 OSC FIL
1 HVPS
18 PA FIL
11 –180VDC
14 PA PLATE CURRENT
M101 0-800 MA PA PLATE CURRENT


1ST MIXER
V201
12AT7
R203
100 K
C229
8-50
C203
240
C202
8-50
L201
L203
C206
2
C205
200
C207
8-50
L206
2.2 MH
C230
430
C231
39
C201
.01 UF
R204
10 K
C205
.01 UF
R205
4.7K
L247
C297
1000
R224
47
1ST AMPLIFIER
V202
6BA6
C209
.01 UF
R210
47 K
C210
.01 UF
R206
220
ALC
ZERO
R207
100
C225
1000
R209
150
C226
1000
R211
22 K
R212
1 K
C218
2
C211
8-50
C212
220
L204
L206
C216
200
C217
8-50
C213
.01 UF
C215
.01 UF
R213
47 K
C214
.01 UF
L205
2.2 MH
2ND AMPLIFIER
V203
6BA6
R214
220
C219
.01 UF
C220
.01 UF
R215
47 K
L233
2.2 MH
R216
22 K
R217
1 K
C224
.01 UF
L210
2.2 MH
C293
100
C263
.01 UF
C221
8-50
C222
150
L207
C268
20
C322
8-50
KILOCYCLES
S201C
+ 275 VDC
MASTER OSCILLATOR
Z101
C004
20
C002
10
L001
C003
10
C001
336
L002
MULTIMETER
S701
PA FIL
PA SCREEN
ALC
PA GRID
2000 VDC
R705
1
M201
0-1
MA
R706A
10
R706B
10
C227
1000
S201A
Y201
13 MC
Y202
12.5 MC
Y203
11.7 MC
Y204
9 MC
Y205
11 MC
Y206
4 MC
CRYSTAL OSC
V208
6AU6
R233
100 K
C234
15
C233
150
L211
.5 MH
R221
470 K
C235
.01 UF
BAND CHANGE
C262
.01 UF
L228
2.2 UH
C312
.01 UF
R222
4700
C243
.01 UF
26MC
25MC
L212
L213
C251
5
L214
C238
10
TUNE OPERATE
OFF
ON
S204
R703
22 K
R702
18 K
ALC
ADJUST
R704
10 K
R701
4700
EMISSION
S101B
FRONT
SSB
CAL
AM
CAL
CW
ST BY
CR702
1N34A
R707
3900
CR701
1N34A
S101A
FRONT
S101C
REAR
C299
1000
KEYING NETWORK
R137
1 MEG
R139
100 K
C127
.1 UF
C129
.01 UF
R136
10 K
C134
.1UF
R141
22 K
R138
2700
VOLTAGE
REGULATOR
V106
OB2
V105
OB2
R131
1800
R132
470 K
R133
68 K
FIL REG
RT101
3TF4A
C347
.01UF
C339
1000
C340
1000
C341
1000
C343
1000
C350
.01UF
C349
.01UF
C344
1000
C348
.01UF
C342
1000
C351
.01UF
C345
1000
C346
1000
L257
L258
C314
.01
L259
2MH
L261
2MH
L268
L266
L262
2MH
L265
L260
2MH
L269
L263
2MH
L267
J103
8
9
3
16
17
19
7
15
12
20
5
2
4
1
18
11
14
TUNE OPERATE
+ 350VDC
GROUND
HOT AC
HV METER
6.3VAC
OSC FIL
PA BIAS
OSC FIL
HVPS
PA FIL
− 150 VDC
PA PLATE CURRENT
0-800
MA
M101
PA PLATE
CURRENT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VIF
J206
C222 150
L207
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C268 20
C322 8-50
C232 62
C352 5
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V204 12AT7
R245 4700
R219 220
R220 100 K
R218 100K
C236 510
XTAL INJ
J205
C244 5
L270 2MH
L222 2.2 MH
L220 47 UH
C245 .01 UF
C249 5-25
R223 10K
C246 .01 UF
C239 10
L221
S201D
C256 3-12
C254 5-25
C255 3-12
C252 8-50
L219
L218
C250 8-50
C247 82
C248 8-50
C329 15
L223
3 RD AMPLIFIER
V209 6BA6
L224 22 MH
C258 470
R232 22 K
C259 .01 UF
R234 47 K
C261 .01 UF
R235 560
C260 .01 UF
R230 1K
C257 3-12
C302 5-25
C301 5-25
R237 2700
L229
C304 8-50
L202 2.2 MH
L246 2.2 MH
C300 1000
+ 275 VDC
C290 1000
S201B
25 MC
23.4 MC
18 MC
11 MC
4 MC
L213
C251 5
L214
C238 10
L215
C240 20
L216
C241 75
L217
C242 220
6CL6 PLATE
J201
C317 5
C277 1.5
C281 5
C237 33
C715 8-50
C283 5-25
E203
E204
C279 .01 UF
L238 2.2 MH
R231 4700
C303 .033 UF
C305 500
L701
DRIVER V206 6CL6
DRIVER V207 6CL6
C319 .01 UF
C320 .01 UF
C321 .01 UF
C278 .01 UF
S201 I
C708 5-12
C331 15
L705
C707 8-50
L704
L702
L703
C713 8-50
C712 8-50
C711 8-50
C710 8-50
C703 390
C704 150
R208 8200
E202
E201
R706 1K
L706 .5
C714 1000
R229 18 K
C318 5
C310 .01 UF
J207
6CL6 GRID
6CL6 CATHODE
J208
L249 .22MH
C298 1000
L239 2.2 MH
C328 1000
DIAL LIGHTS
METER I 701
VERNIER I 101
BAND I 102
BAND I 103
METER I 104
R131 1800
R132 470 K
R133 56 K
FIL REG RT101 3TF4A
V103
V102
V101
V107
V104
V201
V204
V202
V203
V208
V209
V205
V206
V207
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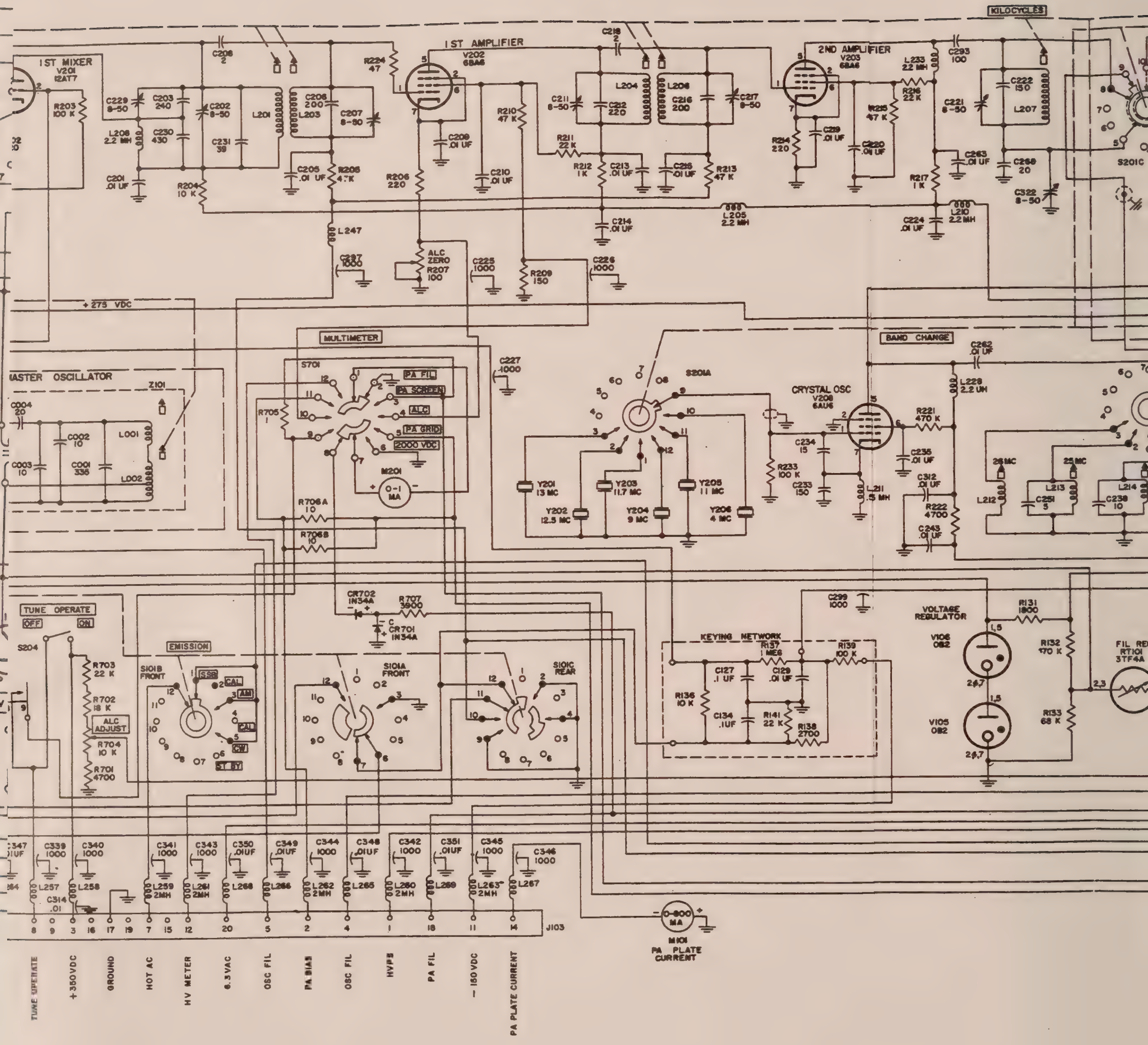
C291 1000
C292 1000
L248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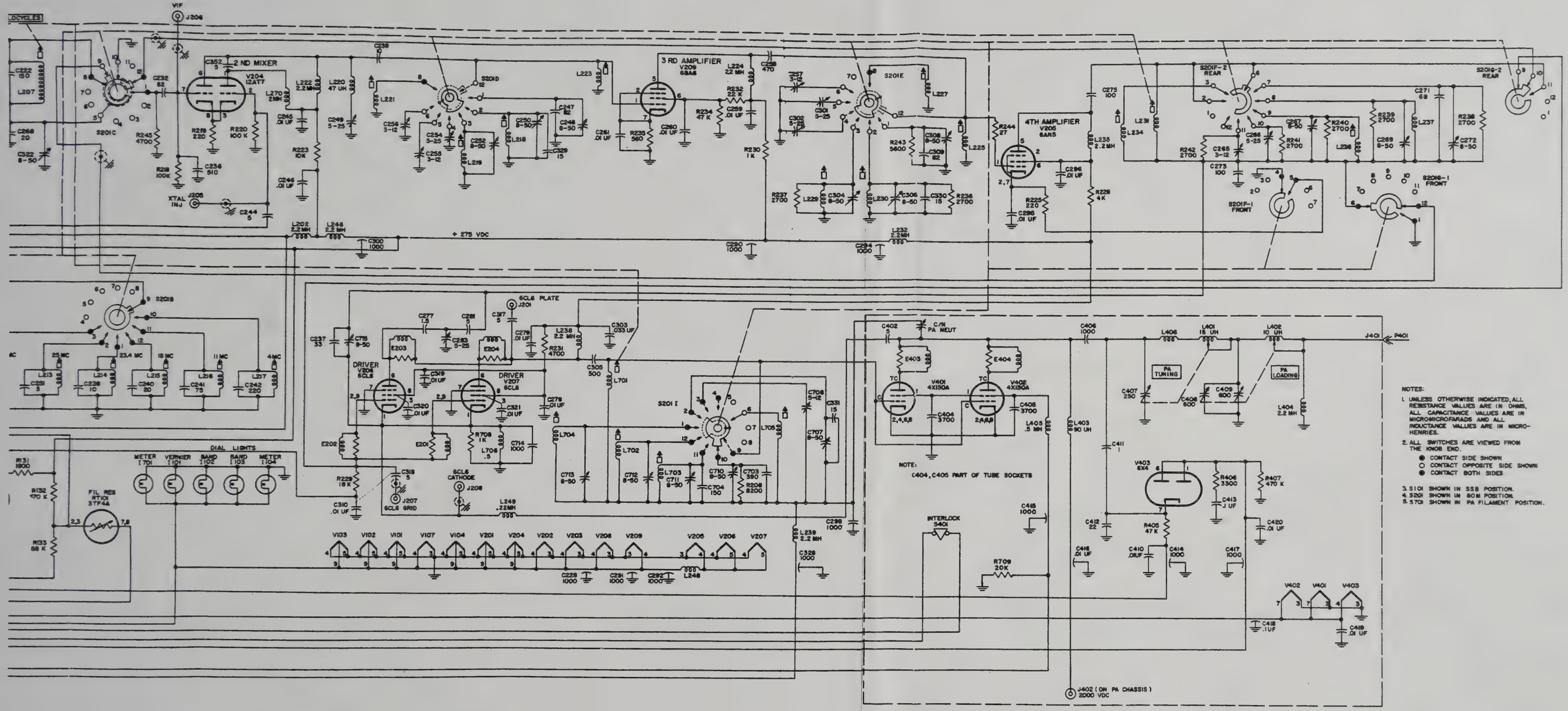
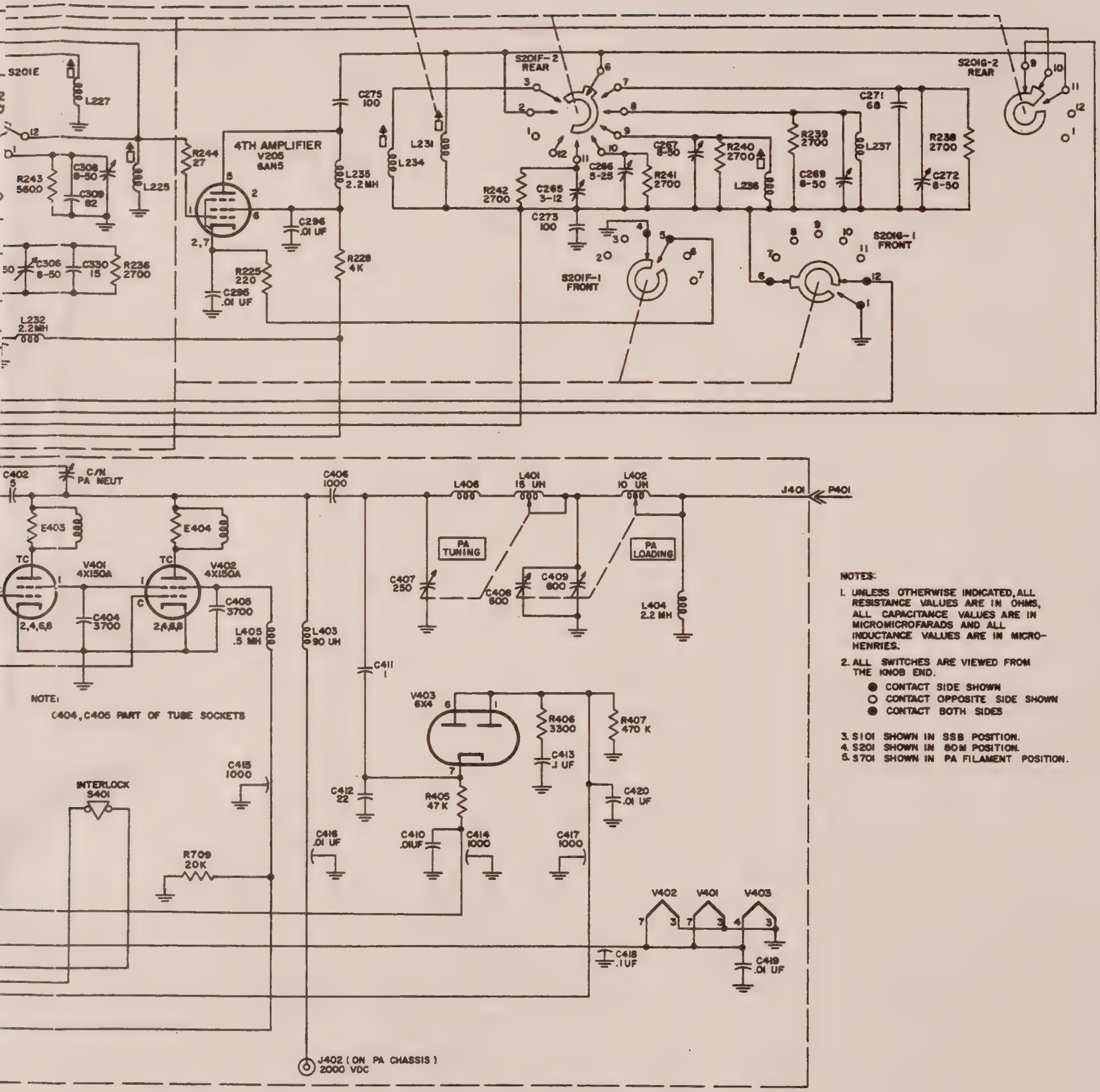
1ST MIXER
V201
12AT7
R203
100 K
C229
8-50
C203
240
C202
8-50
L201
C208
2
C206
200
C207
8-50
L203
L208
2.2 MH
C230
430
C231
39
C201
.01 UF
R204
10 K
C205
.01 UF
R205
4.7K
L247
C287
1000
R224
47
1ST AMPLIFIER
V202
6BA6
C209
.01 UF
C210
.01 UF
R206
220
R210
47 K
ALC
ZERO
R207
100
C225
1000
R209
150
C226
1000
C218
2
C211
8-50
C212
220
L204
L206
C216
200
C217
8-50
R211
22 K
R212
1 K
C213
.01 UF
C215
.01 UF
R213
47 K
C214
.01 UF
L205
2.2 MH
2ND AMPLIFIER
V203
6BA6
R214
220
C219
.01 UF
R215
47 K
C220
.01 UF
L233
2.2 MH
R216
22 K
C293
100
R217
1 K
C263
.01 UF
C224
.01 UF
L210
2.2 MH
C222
150
C221
8-50
L207
C268
20
C322
8-50
S201C
+275 VDC
MASTER OSCILLATOR
Z101
C004
20
C002
10
L001
C003
10
C001
335
L002
MULTIMETER
S701
PA FIL
PA SCREEN
ALC
PA GRID
2000 VDC
R705
1
M201
0-1
MA
R706A
10
R706B
10
C227
1000
S201A
Y201
13 MC
Y202
12.5 MC
Y203
11.7 MC
Y204
9 MC
Y205
11 MC
Y206
4 MC
CRYSTAL OSC
V208
6AU6
R233
100 K
C234
15
C233
150
L211
.5 MH
C235
.01 UF
R221
470 K
C312
.01 UF
R222
4700
C243
.01 UF
BAND CHANGE
C262
.01 UF
L228
2.2 UH
26MC
25MC
L212
C251
5
L213
L214
C238
10
TUNE OPERATE
OFF
ON
S204
R703
22 K
R702
18 K
ALC
ADJUST
R704
10 K
R701
4700
EMISSION
S101B
FRONT
SSB
CAL
AM
CAL
CW
ST BY
CR702
1N34A
R707
3900
CR701
1N34A
S101A
FRONT
S101C
REAR
C299
1000
KEYING NETWORK
R137
1 MEG
R139
100 K
C127
.1 UF
C129
.01 UF
R136
10 K
C134
.1UF
R141
22 K
R138
2700
VOLTAGE
REGULATOR
V106
OB2
V105
OB2
R131
1800
R132
470 K
R133
68 K
FIL RE
RT101
3TF4A
C347
.01UF
C339
1000
C340
1000
C341
1000
C343
1000
C350
.01UF
C349
.01UF
C344
1000
C348
.01UF
C342
1000
C351
.01UF
C345
1000
C346
1000
L257
L258
C314
.01
L259
2MH
L261
2MH
L268
L266
L262
2MH
L265
L260
2MH
L269
L263
2MH
L267
J103
8
9
3
16
17
19
7
15
12
20
5
2
4
1
18
11
14
0-800
MA
M101
PA PLATE
CURRENT
TUNE OPERATE
+350VDC
GROUND
HOT AC
HV METER
6.3VAC
OSC FIL
PA BIAS
OSC FIL
HVPS
PA FIL
-150VDC
PA PLATE CURRENT



NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ALL SWITCHES ARE VIEWED FROM THE KNOB END.
   - ● CONTACT SIDE SHOWN
   - ○ CONTACT OPPOSITE SIDE SHOWN
   - ● CONTACT BOTH SIDES
3. S101 SHOWN IN SSB POSITION.
4. S201 SHOWN IN 80M POSITION.
5. S701 SHOWN IN PA FILAMENT POSITION.

Figure 7-1. Exciter/Power Amplifier, Complete Schematic Diagram



NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICRO-HENRIES.
2. ALL SWITCHES ARE VIEWED FROM THE KNOB END.
   - ● CONTACT SIDE SHOWN
   - ○ CONTACT OPPOSITE SIDE SHOWN
   - ● CONTACT BOTH SIDES
3. S101 SHOWN IN SSB POSITION.
4. S201 SHOWN IN 80M POSITION.
5. S701 SHOWN IN PA FILAMENT POSITION.

Figure 7-1. Exciter/Power Amplifier, Complete Schematic Diagram

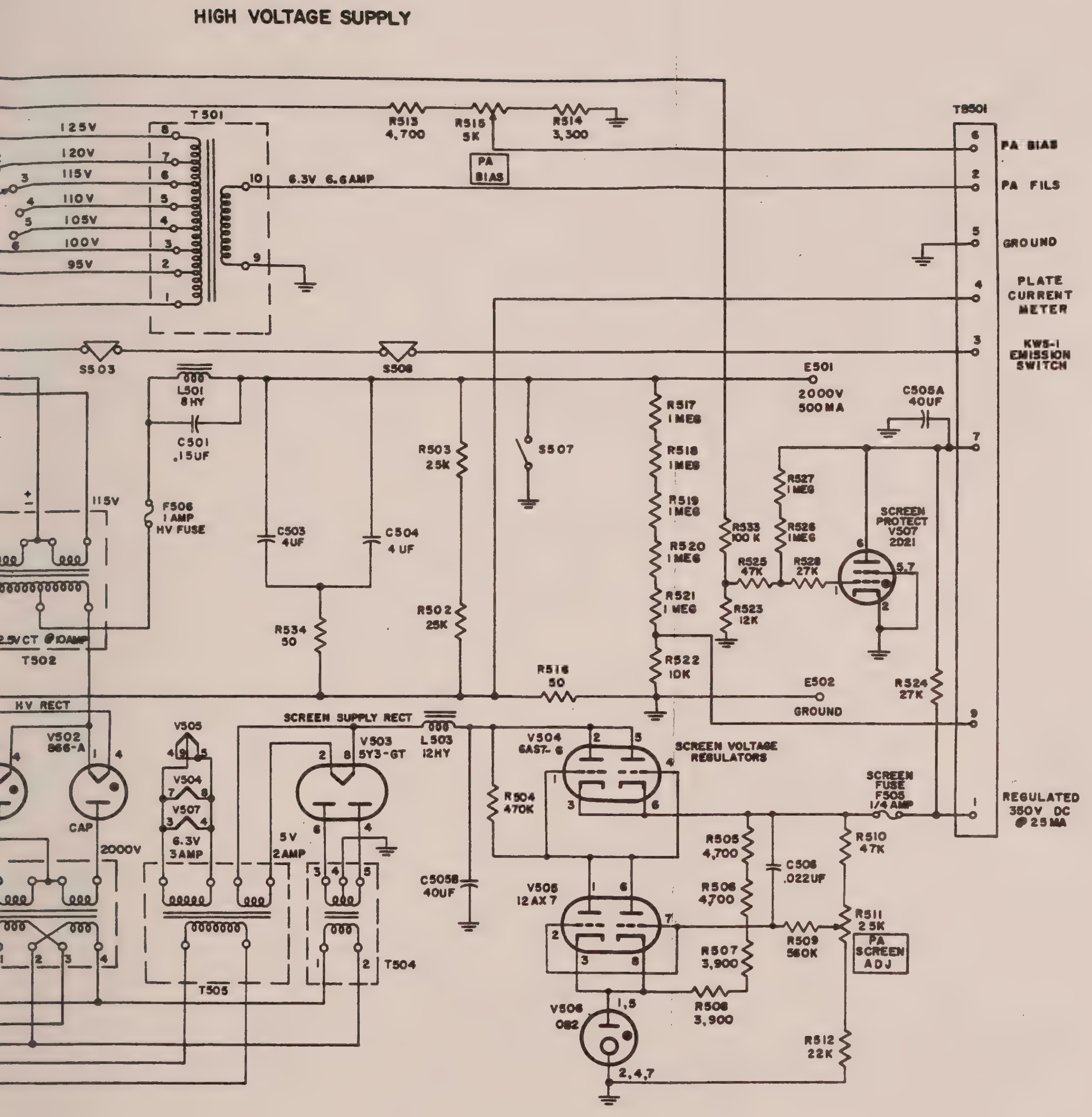
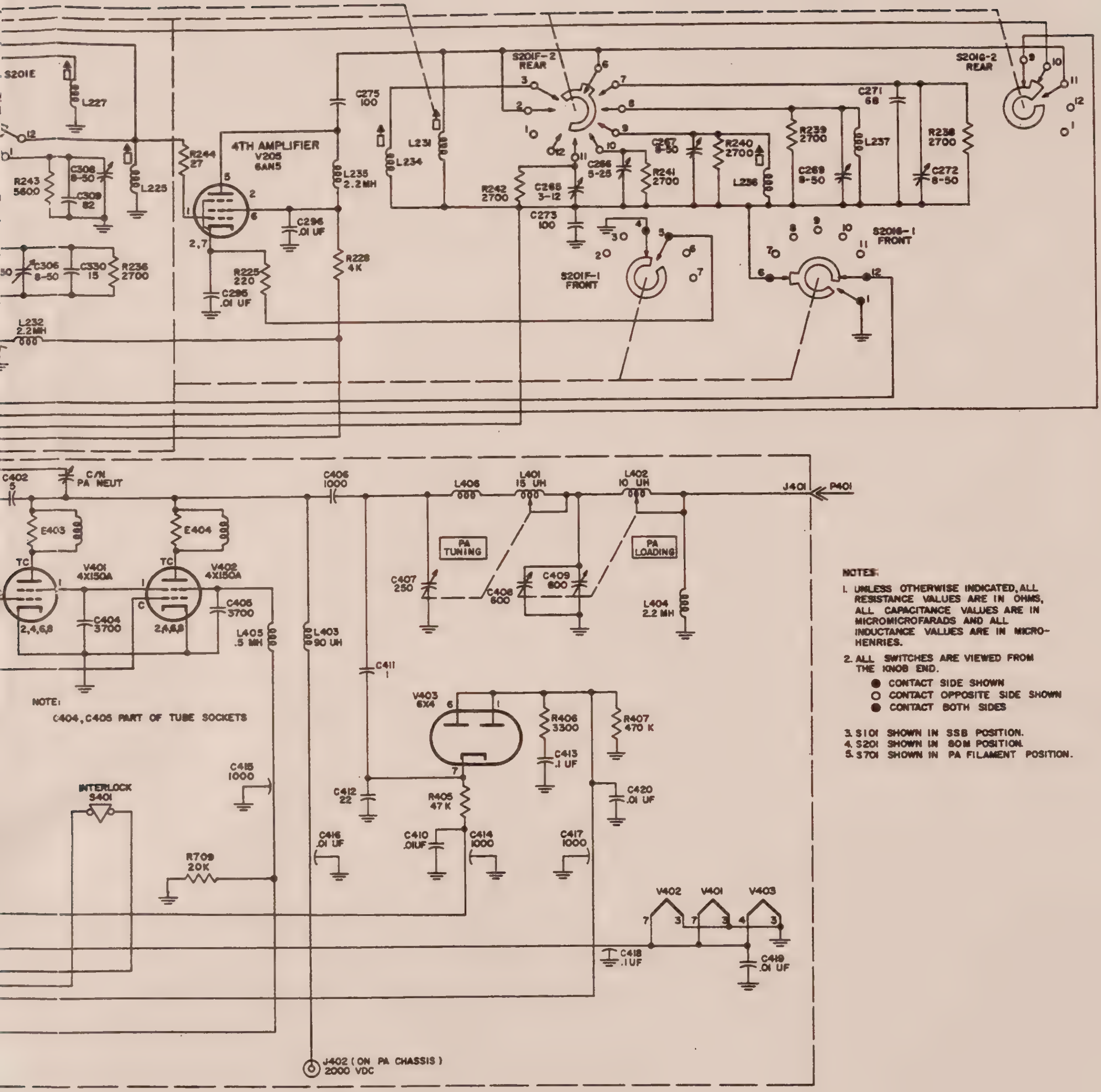


Figure 7-2. Power Supply, Complete Schematic Diagram



NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ALL SWITCHES ARE VIEWED FROM THE KNOB END.
   - ● CONTACT SIDE SHOWN
   - ○ CONTACT OPPOSITE SIDE SHOWN
   - ◐ CONTACT BOTH SIDES
3. S101 SHOWN IN SSB POSITION.
4. S201 SHOWN IN 80M POSITION.
5. S701 SHOWN IN PA FILAMENT POSITION.

Figure 7-1. Exciter/Power Amplifier, Complete Schematic Diagram

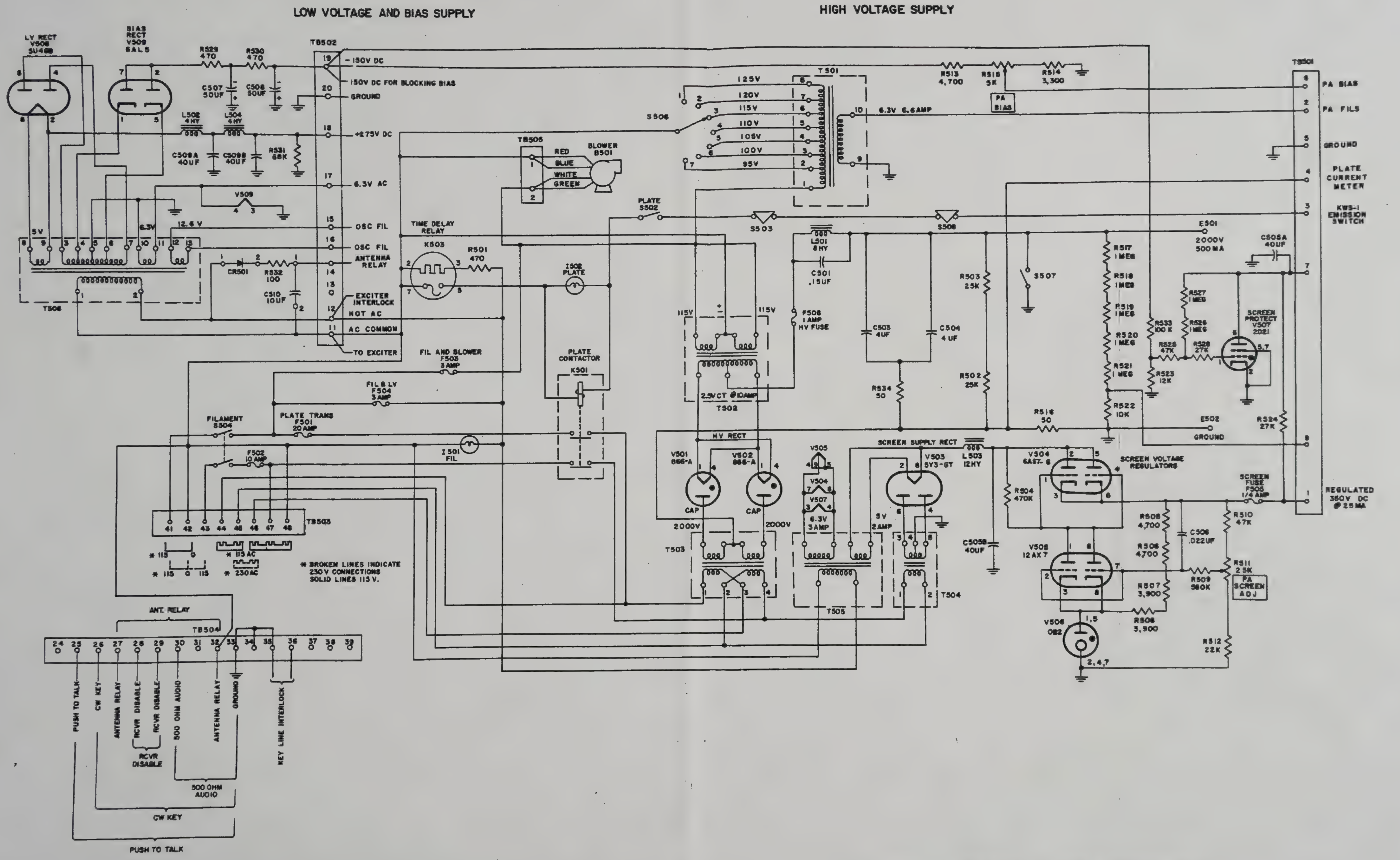
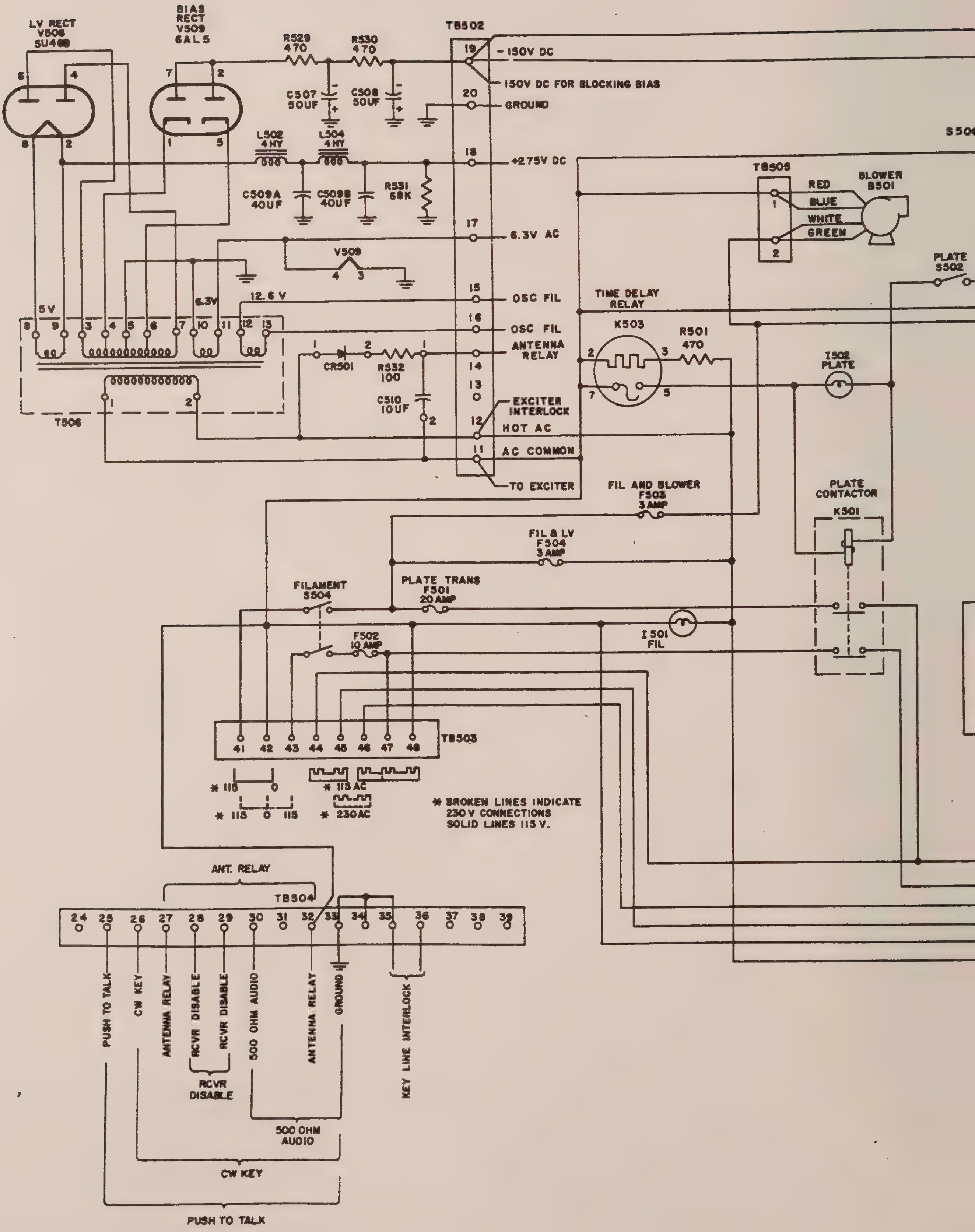
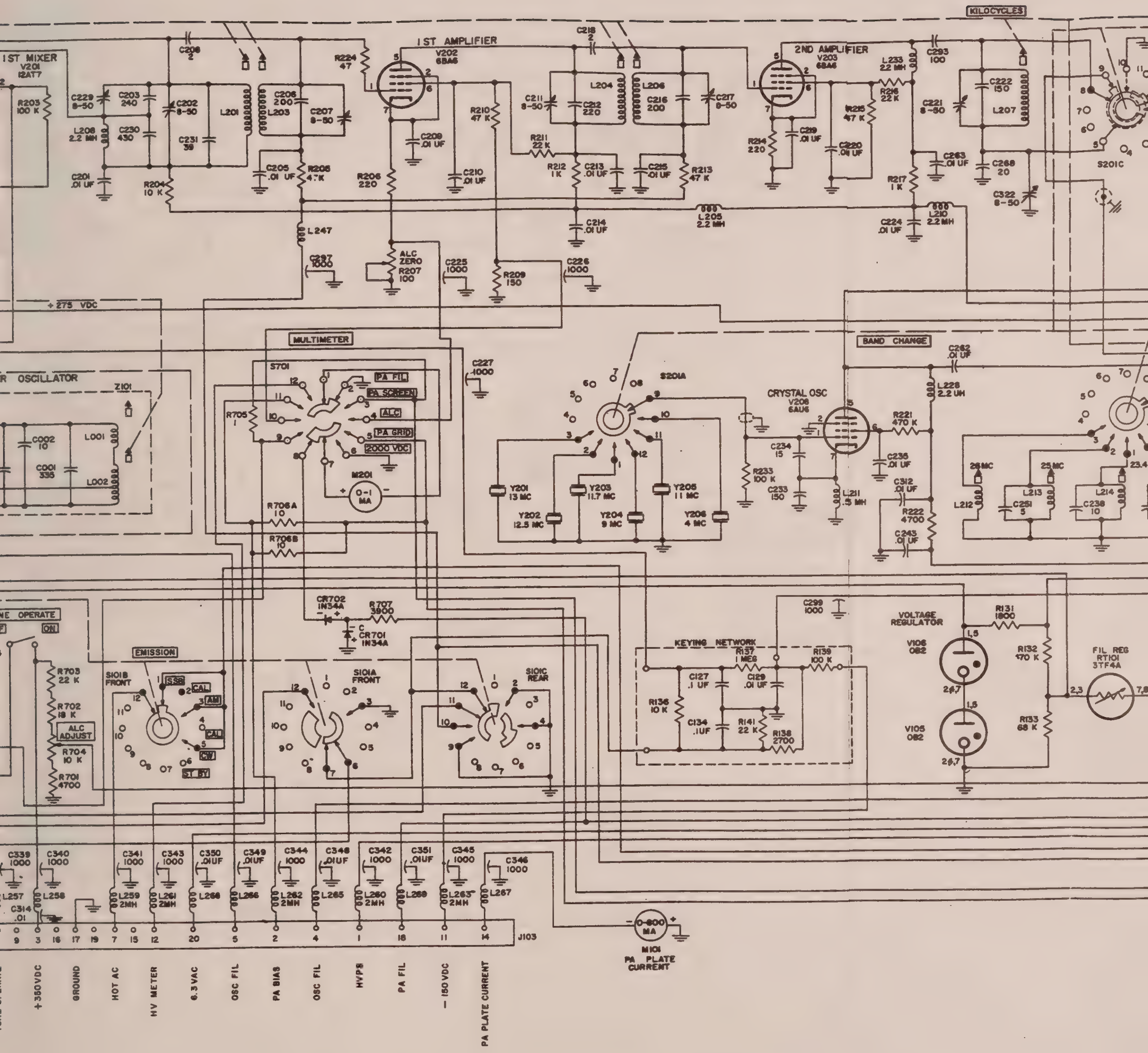


Figure 7-2. Power Supply, Complete Schematic Diagram

LOW VOLTAGE AND BIAS SUPPLY

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V201
12AT7
R203
100 K
C229
8-50
C203
240
C202
8-50
C206
2
L201
C208
200
L203
C207
8-50
L208
2.2 MH
C230
430
C231
39
C205
.01 UF
R205
47K
C201
.01 UF
R204
10 K
L247
C297
1000
1ST AMPLIFIER
V202
6BA6
R224
47
R210
47 K
C209
.01 UF
C210
.01 UF
R206
220
ALC
ZERO
R207
100
C225
1000
R209
150
C226
1000
C218
2
C211
8-50
C212
220
L204
L206
C216
200
C217
8-50
R211
22 K
R212
1 K
C213
.01 UF
C215
.01 UF
R213
47 K
C214
.01 UF
L205
2.2 MH
2ND AMPLIFIER
V203
6BA6
L233
2.2 MH
C293
100
R216
22 K
R215
47 K
R214
220
C219
.01 UF
C220
.01 UF
R217
1 K
C224
.01 UF
L210
2.2 MH
C221
8-50
C222
150
L207
C263
.01 UF
C268
20
C322
8-50
S201C
+275 VDC
OSCILLATOR
Z101
C002
10
C001
335
L001
L002
MULTIMETER
S701
PA FIL
PA SCREEN
ALC
PA GRID
2000 VDC
R705
1
M201
0-1
MA
R706A
10
R706B
10
C227
1000
S201A
Y201
13 MC
Y202
12.5 MC
Y203
11.7 MC
Y204
9 MC
Y205
11 MC
Y206
4 MC
BAND CHANGE
C262
.01 UF
L228
2.2 UH
CRYSTAL OSC
V206
6AU6
R221
470 K
R233
100 K
C234
15
C233
150
C235
.01 UF
L211
.5 MH
C312
.01 UF
R222
4700
C243
.01 UF
L212
26MC
25MC
L213
C251
5
L214
C238
10
23.4
CR702
1N34A
R707
3900
CR701
1N34A
TUNE OPERATE
OFF
ON
R703
22 K
R702
18 K
ALC
ADJUST
R704
10 K
R701
4700
EMISSION
S101B
FRONT
SSB
CAL
AM
CAL
CW
ST BY
S101A
FRONT
S101C
REAR
C299
1000
KEYING NETWORK
R137
1 MEG
R139
100 K
C127
.1 UF
C129
.01 UF
R136
10 K
C134
.1UF
R141
22 K
R138
2700
VOLTAGE
REGULATOR
V106
0B2
V105
0B2
R131
1800
R132
470 K
R133
68 K
FIL REG
RT101
3TF4A
C339
1000
C340
1000
L257
L258
C314
.01
C341
1000
C343
1000
C350
.01UF
C349
.01UF
C344
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C348
.01UF
C342
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C351
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C345
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C346
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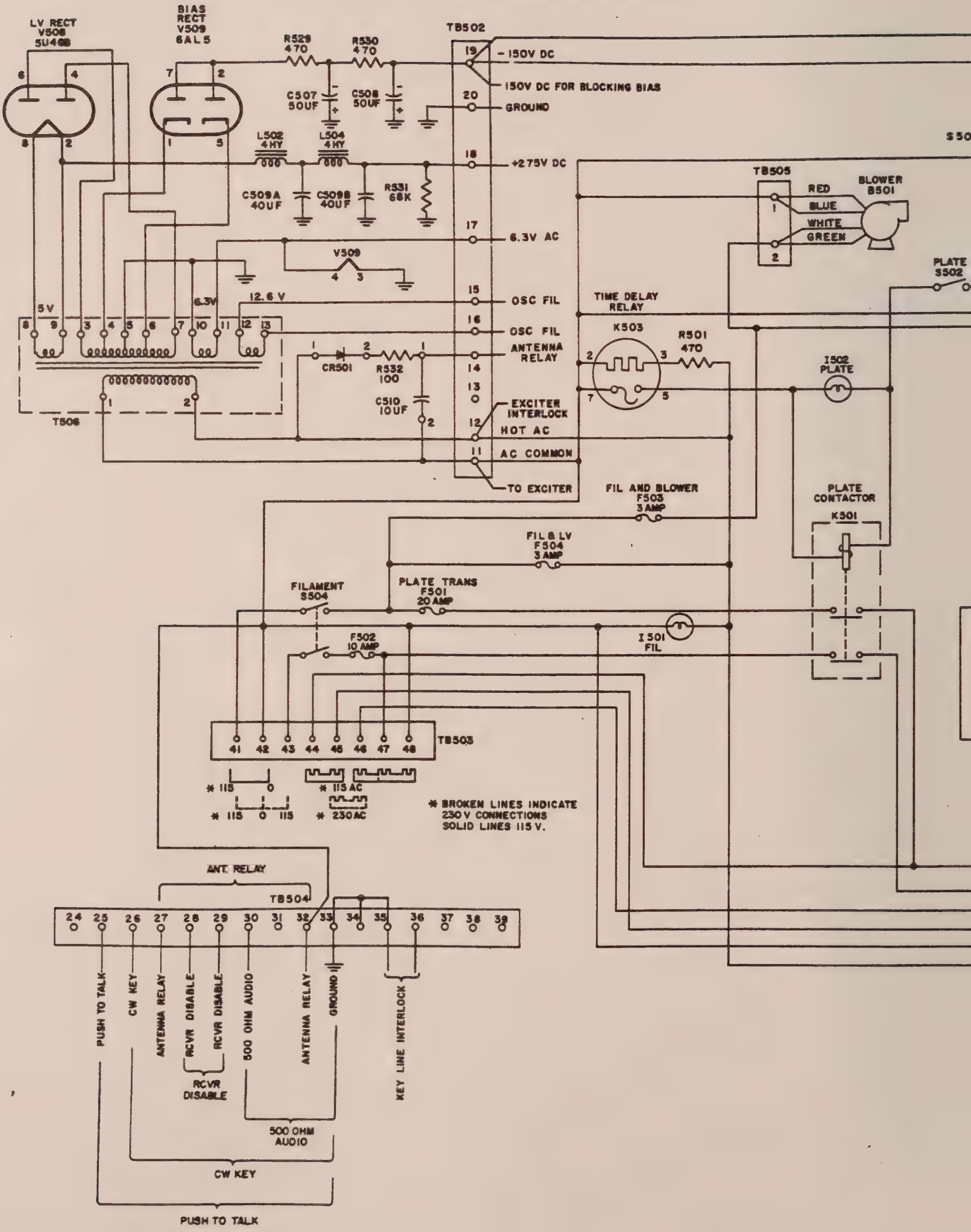
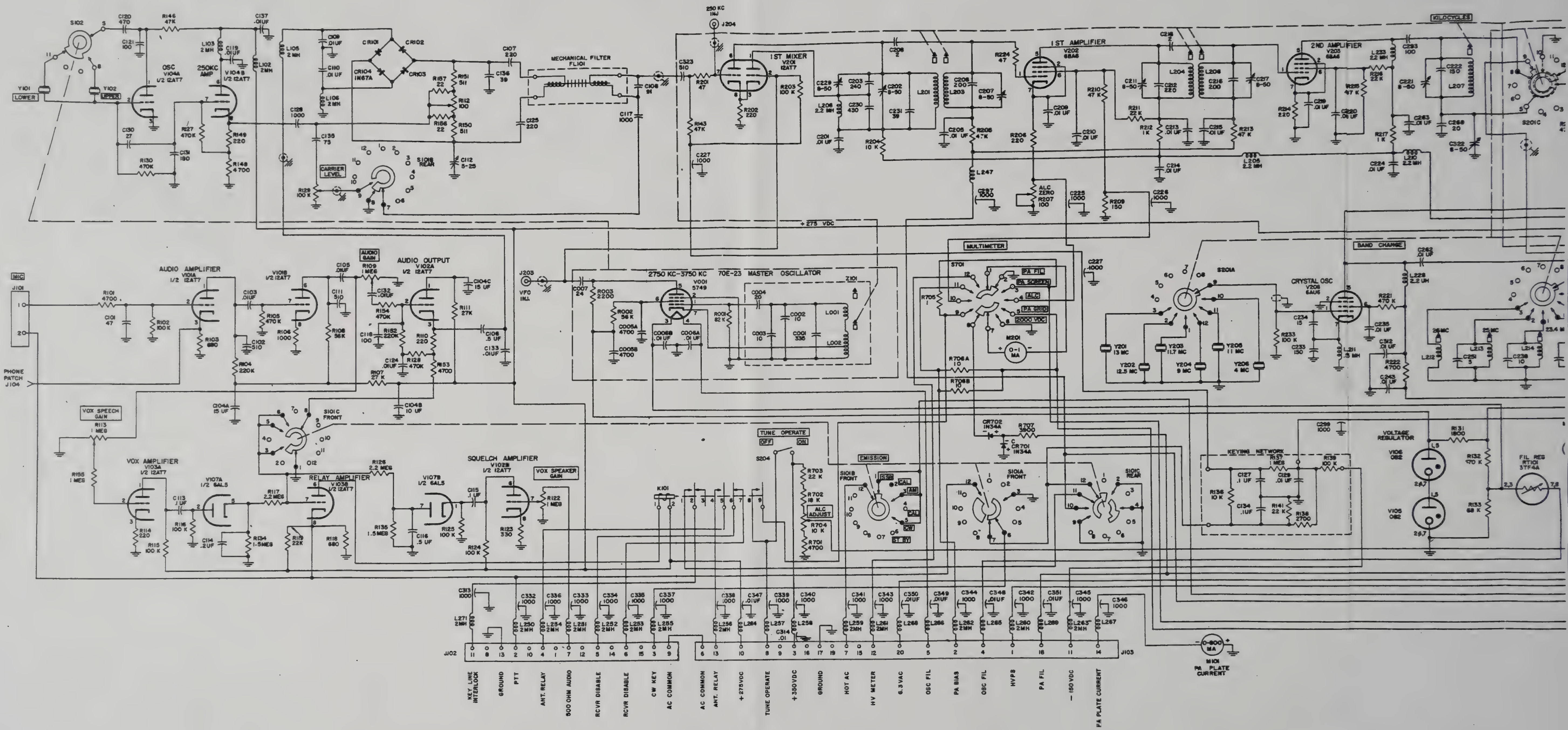
2MH
L261
2MH
L266
L266
L262
2MH
L265
L260
2MH
L269
L263
2MH
L267
J103
+350VDC
GROUND
HOT AC
HV METER
6.3VAC
OSC FIL
PA BIAS
OSC FIL
HVPS
PA FIL
-150VDC
PA PLATE CURRENT
0-800
MA
M101
PA PLATE
CURRENT

LOW VOLTAGE AND BIAS SUPPLY



* BROKEN LINES INDICATE 230 V CONNECTIONS SOLID LINES 115 V.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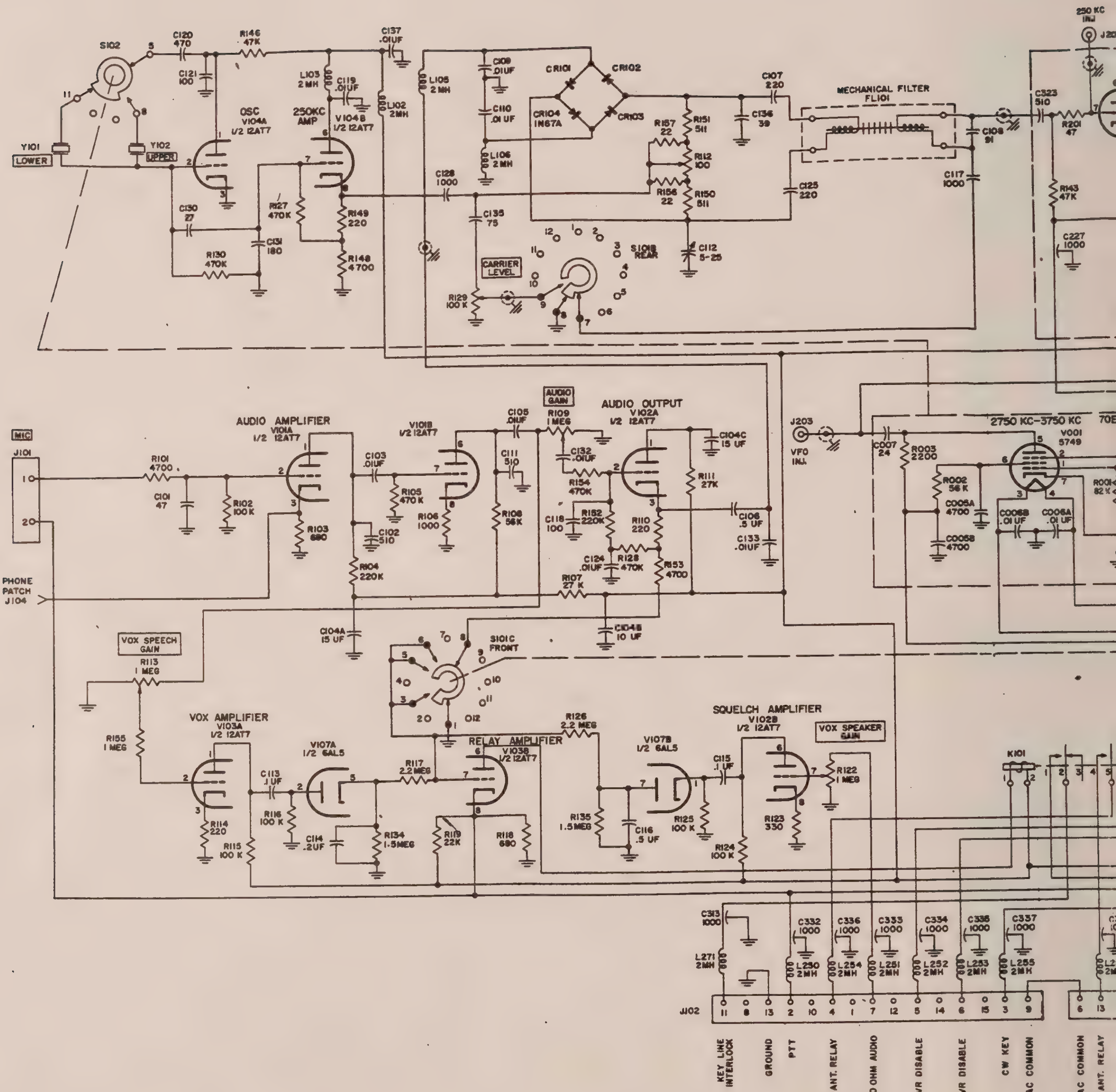
250KC AMP V104B 1/2 12AT7
LOWER
UPPER
S102
CARRIER LEVEL
S101B REAR
MECHANICAL FILTER FL101
250 KC INJ J204
1ST MIXER V201 12AT7
1ST AMPLIFIER V202 6BA6
2ND AMPLIFIER V203 6BA6
KILOCYCLES
S201C
ALC ZERO R207 100
+275 VDC
MIC J101
AUDIO AMPLIFIER V101A 1/2 12AT7
V101B 1/2 12AT7
AUDIO GAIN
AUDIO OUTPUT V102A 1/2 12AT7
PHONE PATCH J104
VFO INJ. J203
2750 KC-3750 KC 70E-23 MASTER OSCILLATOR
V001 5749
Z101
MULTIMETER
S701
PA FIL
PA SCREEN
ALC
PA GRID
2000 VDC
M201 0-1 MA
S201A
BAND CHANGE
CRYSTAL OSC V206 6AU6
VOX SPEECH GAIN
VOX AMPLIFIER V103A 1/2 12AT7
V107A 1/2 6AL5
RELAY AMPLIFIER V103B 1/2 12AT7
S101C FRONT
SQUELCH AMPLIFIER V102B 1/2 12AT7
V107B 1/2 6AL5
VOX SPEAKER GAIN
K101
TUNE OPERATE
OFF ON
S204
ALC ADJUST
EMISSION
S101B FRONT
USB
LSB
CAL
AM
CW
ST BY
S101A FRONT
S101C REAR
KEYING NETWORK
VOLTAGE REGULATOR
V106 OB2
V105 OB2
FIL REG RT101 3TF4A
J102
KEY LINE INTERLOCK
GROUND
PTT
ANT. RELAY
500 OHM AUDIO
RCVR DISABLE
RCVR DISABLE
CW KEY
AC COMMON
J103
AC COMMON
ANT. RELAY
+275VDC
TUNE OPERATE
+350VDC
GROUND
HOT AC
HV METER
6.3VAC
OSC FIL
PA BIAS
OSC FIL
HVPS
PA FIL
-150VDC
PA PLATE CURRENT
M101 0-800 MA PA PLATE CURRENT



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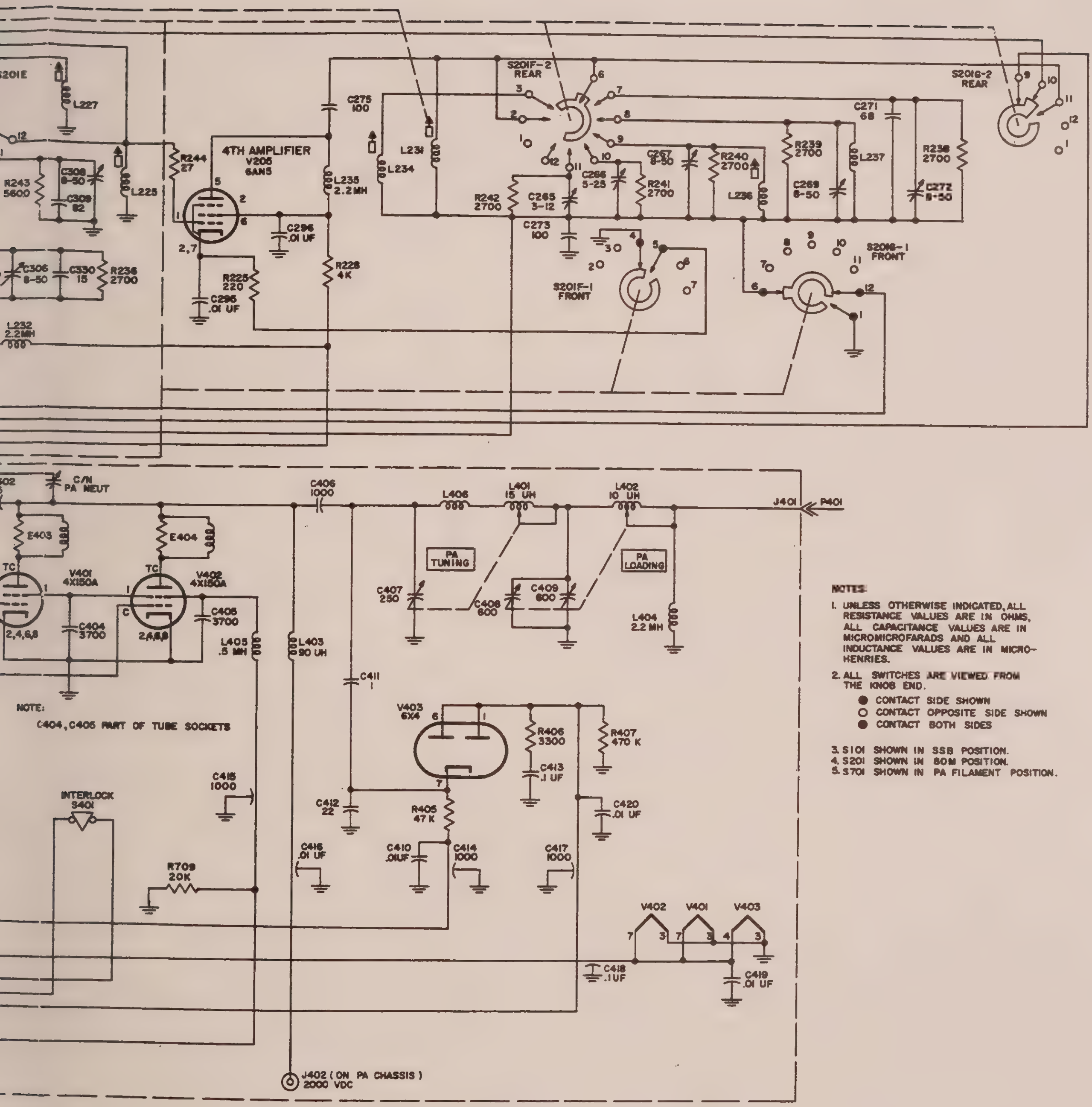
C120 470
R146 47K
C137 .01UF
C121 100
Y101 LOWER
Y102 UPPER
OSC V104A 1/2 12AT7
250KC AMP
V104B 1/2 12AT7
L103 2MH
C119 .01UF
L102 2MH
L105 2MH
C109 .01UF
C110 .01 UF
L106 2MH
CR101
CR102
CR103
CR104 IN67A
C107 220
C136 39
R157 22
R151 511
R112 100
R156 22
R150 511
MECHANICAL FILTER FL101
C108 91
C117 1000
C125 220
C112 5-25
C128 1000
C135 75
R127 470K
R149 220
R148 4700
C130 27
C131 180
R130 470K
CARRIER LEVEL
R129 100 K
S101B REAR
250 KC INJ
J20
C323 510
R201 47
R143 47K
C227 1000
MIC
J101
R101 4700
C101 47
R102 100K
AUDIO AMPLIFIER V101A 1/2 12AT7
R103 680
C103 .01UF
R105 470 K
C102 510
R104 220K
C104A 15 UF
V101B 1/2 12AT7
R106 1000
C105 .01UF
C111 510
R108 56K
AUDIO GAIN
R109 1 MEG
C132 .01UF
R154 470K
AUDIO OUTPUT V102A 1/2 12AT7
C104C 15 UF
R111 27K
C118 100
R152 220K
R110 220
C106 .5 UF
C133 .01UF
C124 .01UF
R128 470K
R153 4700
R107 27 K
C104B 10 UF
PHONE PATCH J104
J203
VFO INJ.
C007 24
R003 2200
2750 KC-3750 KC
V001 5749
R002 56 K
C005A 4700
C005B 4700
C006B .01 UF
C006A .01 UF
R001 82 K
S101C FRONT
VOX SPEECH GAIN
R113 1 MEG
R155 1 MEG
VOX AMPLIFIER V103A 1/2 12AT7
R114 220
R115 100 K
C113 .1 UF
R116 100 K
V107A 1/2 6AL5
C114 .2UF
R134 1.5MEG
R117 2.2 MEG
RELAY AMPLIFIER V103B 1/2 12AT7
R119 22K
R118 680
R126 2.2 MEG
V107B 1/2 6AL5
R135 1.5MEG
C116 .5 UF
C115 .1 UF
R125 100 K
SQUELCH AMPLIFIER V102B 1/2 12AT7
VOX SPEAKER GAIN
R122 1 MEG
R123 330
R124 100 K
K101
C313 1000
L271 2MH
C332 1000
L250 2MH
C336 1000
L254 2MH
C333 1000
L251 2MH
C334 1000
L252 2MH
C335 1000
L253 2MH
C337 1000
L255 2MH
J102
KEY LINE INTERLOCK
GROUND
PTT
ANT. RELAY
500 OHM AUDIO
RCVR DISABLE
RCVR DISABLE
CW KEY
AC COMMON
AC COMMON
ANT. RELAY

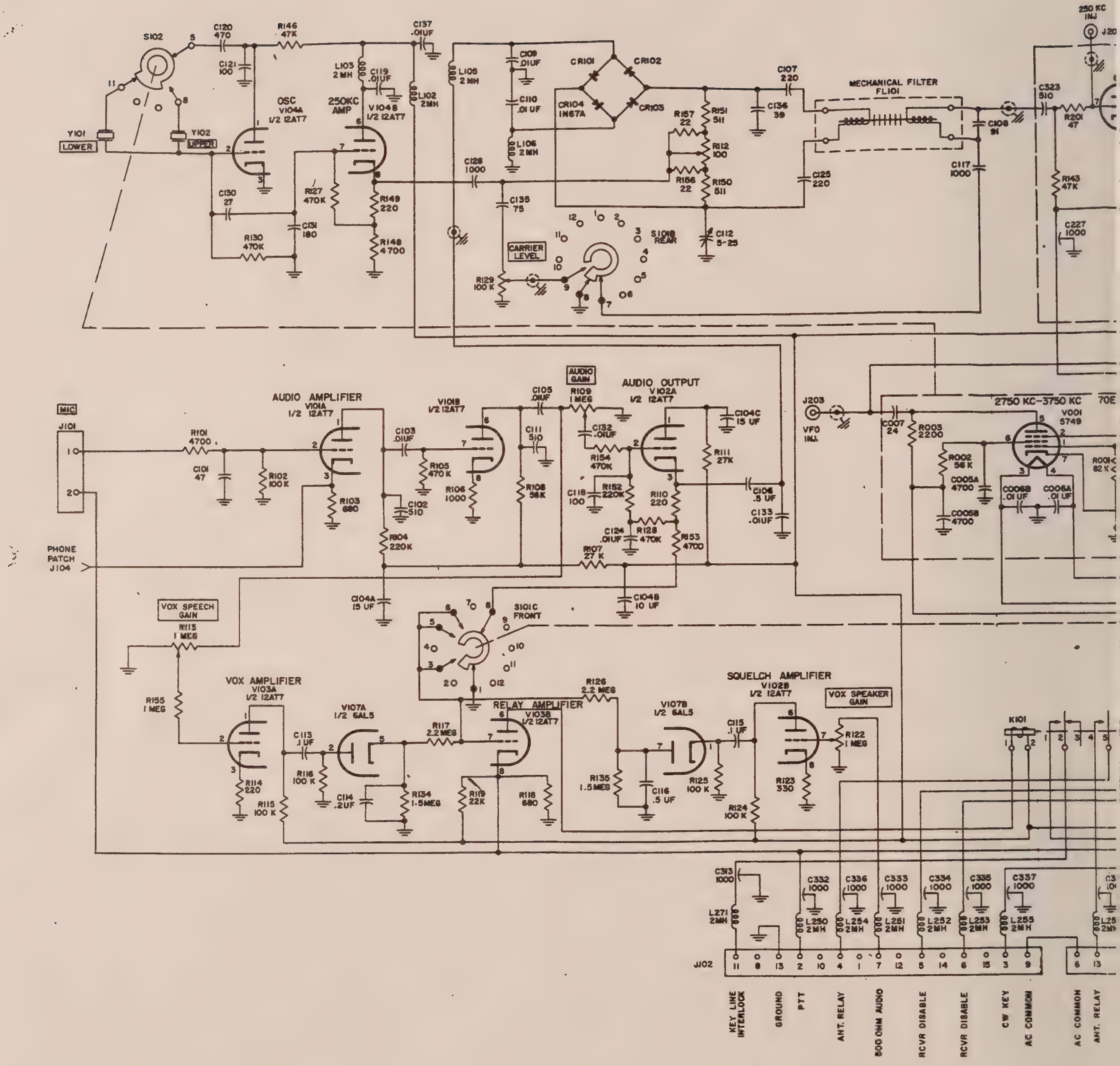


NOTE:
C404, C405 PART OF TUBE SOCKETS

NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICRO-HENRIES.
2. ALL SWITCHES ARE VIEWED FROM THE KNOB END.
   - ● CONTACT SIDE SHOWN
   - ○ CONTACT OPPOSITE SIDE SHOWN
   - ● CONTACT BOTH SIDES
3. S101 SHOWN IN SSB POSITION.
4. S201 SHOWN IN 80M POSITION.
5. S701 SHOWN IN PA FILAMENT POSITION.

Figure 7-1. Exciter/Power Amplifier, Complete Schematic Diagram



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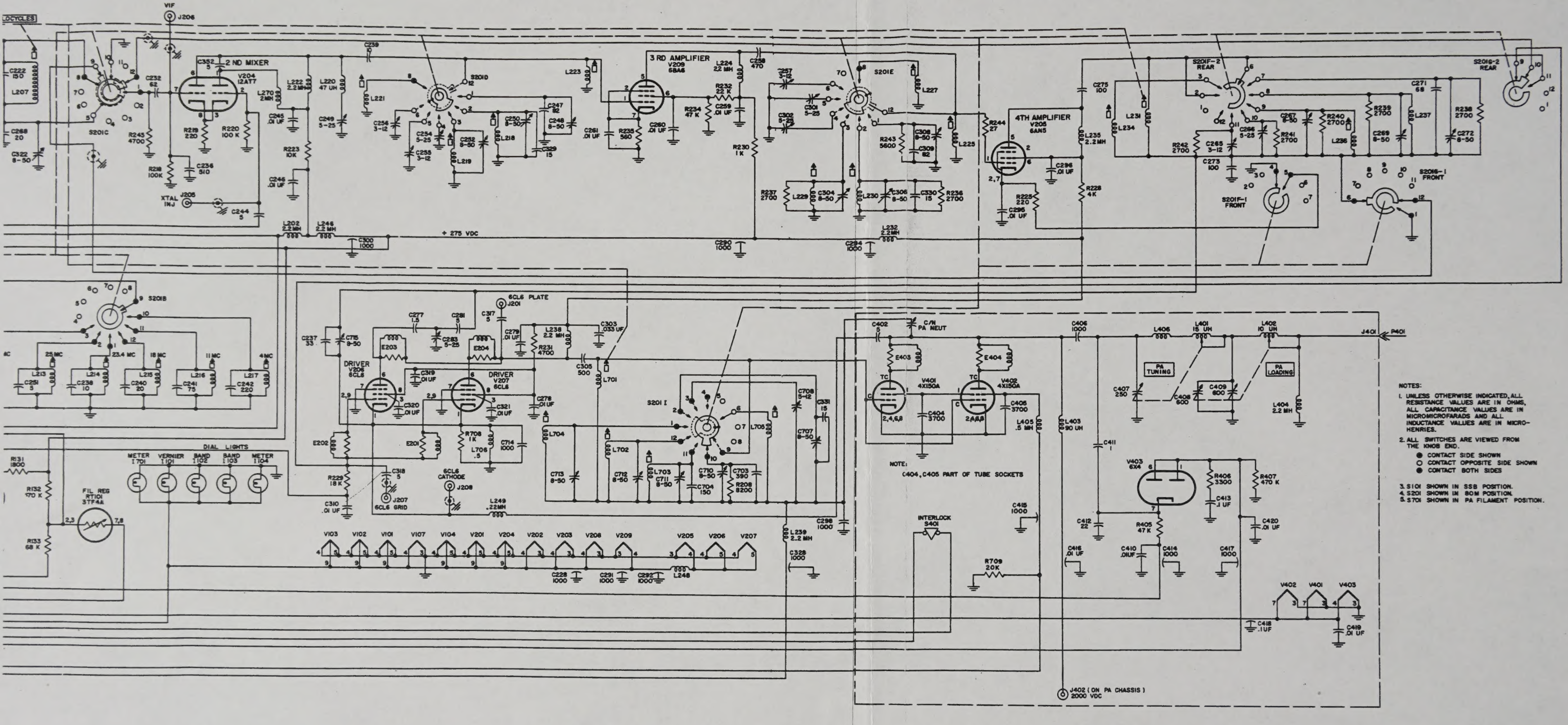
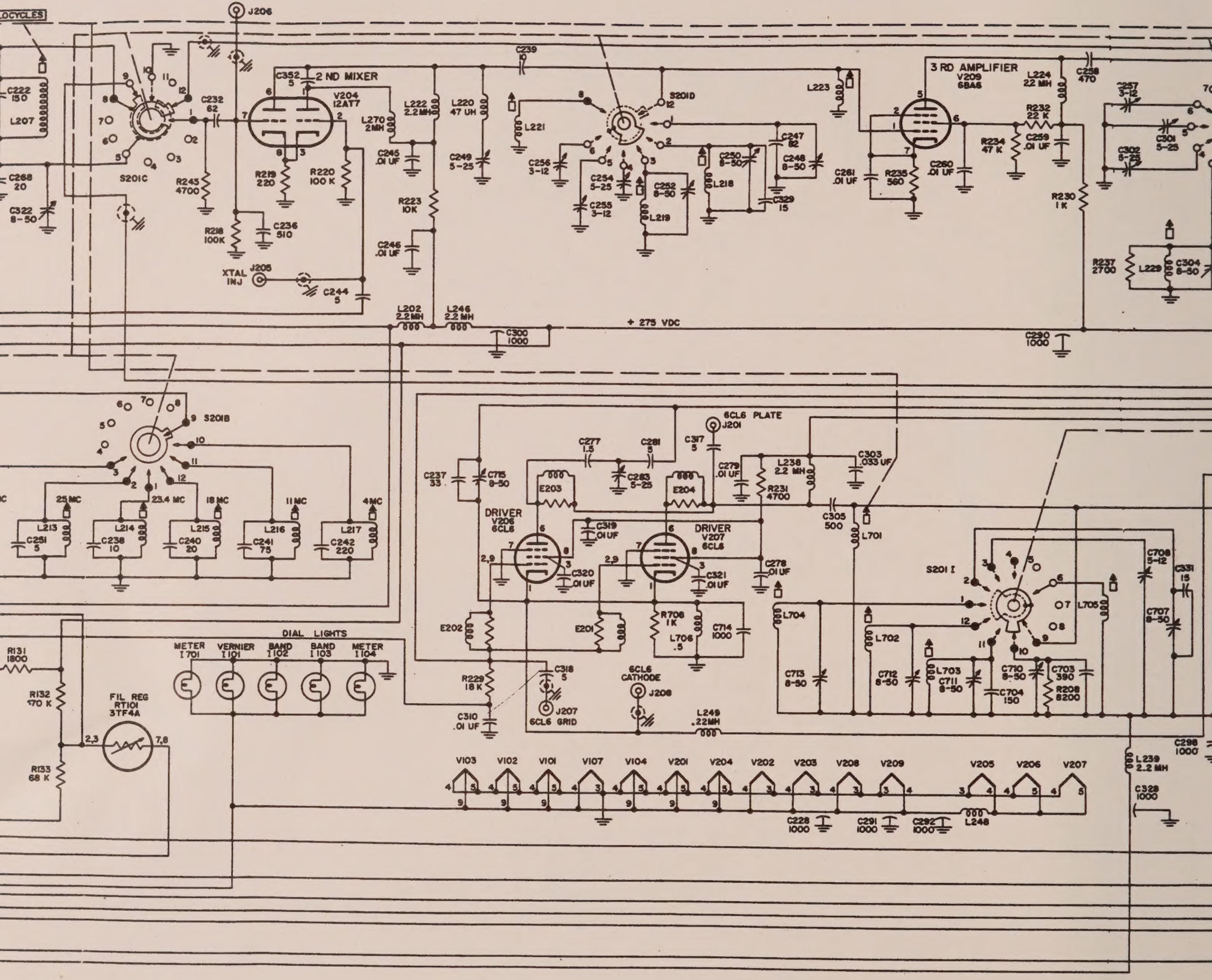
Y101 LOWER
Y102 UPPER
C120 470
C121 100
R146 47K
OSC V104A 1/2 12AT7
C130 27
R130 470K
C131 180
R127 470K
L103 2MH
C119 .01UF
250KC AMP V104B 1/2 12AT7
R149 220
R148 4700
C137 .01UF
L102 2MH
L105 2MH
C109 .01UF
C110 .01UF
L106 2MH
C128 1000
C135 75
CARRIER LEVEL
R129 100K
S101B REAR
CR101
CR102
CR103
CR104 1N67A
R157 22
R156 22
R151 511
R112 100
R150 511
C112 5-25
C107 220
C136 39
C125 220
MECHANICAL FILTER FL101
C108 91
C117 1000
C323 510
R201 47
R143 47K
C227 1000
250 KC INJ
J20
MIC
J101
AUDIO AMPLIFIER V101A 1/2 12AT7
R101 4700
C101 47
R102 100K
R103 680
C103 .01UF
R105 470K
C102 510
R104 220K
C104A 15 UF
V101B 1/2 12AT7
R106 1000
C105 .01UF
C111 510
R108 56K
AUDIO GAIN
R109 1 MEG
C132 .01UF
R154 470K
R152 220K
C118 100
C124 .01UF
R128 470K
R107 27K
C104B 10 UF
AUDIO OUTPUT V102A 1/2 12AT7
C104C 15 UF
R111 27K
R110 220
R153 4700
C106 .5 UF
C133 .01UF
PHONE PATCH J104
VOX SPEECH GAIN
R113 1 MEG
R155 1 MEG
VOX AMPLIFIER V103A 1/2 12AT7
R114 220
R115 100K
C113 .1 UF
R116 100K
V107A 1/2 6AL5
C114 .2UF
R134 1.5MEG
R117 2.2 MEG
S101C FRONT
RELAY AMPLIFIER V103B 1/2 12AT7
R119 22K
R118 680
R126 2.2 MEG
R135 1.5MEG
C116 .5 UF
V107B 1/2 6AL5
R125 100K
C115 .1 UF
SQUELCH AMPLIFIER V102B 1/2 12AT7
R124 100K
R123 330
VOX SPEAKER GAIN
R122 1 MEG
J203 VFO INJ.
C007 24
R003 2200
2750 KC-3750 KC
70E
V001 5749
R002 56K
C005A 4700
C005B 4700
C006B .01 UF
C006A .01 UF
R001 82K
K101
C313 1000
L271 2MH
C332 1000
L250 2MH
C336 1000
L254 2MH
C333 1000
L251 2MH
C334 1000
L252 2MH
C335 1000
L253 2MH
C337 1000
L255 2MH
J102
KEY LINE INTERLOCK
GROUND
PTT
ANT. RELAY
500 OHM AUDIO
RCVR DISABLE
RCVR DISABLE
CW KEY
AC COMMON
AC COMMON
ANT. RELAY



NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ALL SWITCHES ARE VIEWED FROM THE KNOB END.
   - ● CONTACT SIDE SHOWN
   - ○ CONTACT OPPOSITE SIDE SHOWN
   - ● CONTACT BOTH SIDES
3. S101 SHOWN IN SSB POSITION.
4. S201 SHOWN IN 80M POSITION.
5. S701 SHOWN IN PA FILAMENT POSITION.

Figure 7-1. Exciter/Power Amplifier, Complete Schematic Diagram


LOCYCLES
VIF
J206
C222 150
L207
S201C
C232 62
C268 20
C322 8-50
R243 4700
C352 5
2 ND MIXER
V204 12AT7
R219 220
R220 100 K
R218 100K
C236 510
XTAL INJ
J205
C244 5
L270 2MH
L222 2.2 MH
C245 .01 UF
R223 10K
C246 .01 UF
L220 47 UH
C239 10
L221
C249 5-25
C256 3-12
C254 5-25
C255 3-12
S201D
C252 8-50
L219
L218
C250 8-50
C247 82
C248 8-50
C329 15
L223
3 RD AMPLIFIER
V209 6BA6
C261 .01 UF
R235 560
C260 .01 UF
L224 22 MH
R232 22 K
R234 47 K
C259 .01 UF
C258 470
R230 1 K
C257 3-12
C301 5-25
C302 5-25
R237 2700
L229
C304 8-50
L202 2.2 MH
L246 2.2 MH
C300 1000
+ 275 VDC
C290 1000
S201B
25 MC
23.4 MC
18 MC
11 MC
4 MC
L213
C251 5
L214
C238 10
L215
C240 20
L216
C241 75
L217
C242 220
6CL6 PLATE
J201
C237 33
C715 8-50
C277 1.5
C281 5
C283 5-25
C317 5
C279 .01 UF
R231 4700
L238 2.2 MH
C303 .033 UF
E203
E204
DRIVER V206 6CL6
DRIVER V207 6CL6
C319 .01 UF
C320 .01 UF
C321 .01 UF
C278 .01 UF
C305 500
L701
E202
E201
R706 1K
L706 .5
C714 1000
R229 18 K
C318 5
J207 6CL6 GRID
C310 .01 UF
6CL6 CATHODE
J208
L249 .22 MH
S201 I
L704
L702
L703
C713 8-50
C712 8-50
C711 8-50
C704 150
C710 8-50
C703 390
R208 8200
L705
C708 5-12
C331 15
C707 8-50
C298 1000
L239 2.2 MH
C328 1000
R131 1800
R132 470 K
R133 68 K
FIL REG RT101 3TF4A
DIAL LIGHTS
METER I 701
VERNIER I 101
BAND I 102
BAND I 103
METER I 104
V103
V102
V101
V107
V104
V201
V204
V202
V203
V208
V209
V205
V206
V207
C228 1000
C291 1000
C292 1000
L248

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